POWER

A McGRAW-HILL PUBLICATION—ESTABLISHED 1884
ELY C. HUTCHINSON, *Editor*

Volume 71 NEW YORK, APRIL 8, 1930 *Number* 14

Regarding Nothing

YEARS AGO, as we waited for our coats at the end of an afternoon session of the Institution of Mechanical Engineers, a kindly gentleman, finding that I was alone, suggested that we dine together.

He turned out to be the noted physicist George MacFarlane Gray. He had published some speculations on the physical properties of steam from the viewpoint of molecular physics, and the talk turned in that direction.

"What do you think," he asked after a little, "that a cubic foot of nothing would look like?"

I fell. "Nothing?" I said. "It would look like nothing. You couldn't see it."

"Wait a minute. Suppose there were a cubic foot of nothing between your eye and that light over there. Could you see it?"

If light is a wave motion in the ether and if there were an island of nothingness between me and the source of the light, I had to admit that the waves could not get through.

"It would be opaque, wouldn't it?" he said, "like a cube of coal. Now suppose a beam of light comes at it from this side. It couldn't get through but would be reflected backward. The cube of nothing would shine like polished silver."

And he went on to demonstrate that it would be heavy, impenetrable to a crowbar, and have most of the attributes of solid matter.

Long since the physicists broke the substances that had been regarded as solid continuous bodies down into aggregations of molecules vibrating around one another at distances vast as compared with their own dimeters. A railroad train crossing a bridge is held up not by the cohesion of material in intimate contact throughout, but, ultimately, by the mutual attraction of these already separated particles.

These molecules are made up of atoms. That has long been known too. But later it has been found that the atom, which was supposed to be the ultimate subdivision of matter, itself consists of a nucleus with electrons revolving about it, and the number of planetary electrons determines whether it is an atom of hydrogen or lead or something else.

And now the electrons and the protons about which they revolve are said to be nothing but charges of electricity, stresses in the ether. Some deny the necessity even of an ether to account for all the manifestations of material and energy.

Might the scientist who boasted "Give me matter and energy and I will create a world" have cut his specification down to simple energy?

Truly "we are such stuff as dreams are made of" and the more we learn of the nature of things the further we get into the ethereal.

F. R. Low

EDITORIALS

Storing Power in Underground Caverns

STORAGE of power as heat energy in underground caverns, once a "fantastic" suggestion, comes forward again as a serious economic proposal. Those attending the meeting of the Metropolitan Section of the A.S.M.E. on March 25 (reported in *Power* last week) were impressed by an analysis of the power possibilities of this problem as presented by F. W. Gay of the Public Service Production Company, Newark, N. J.

Mr. Gay suggests storing water at 2,000 pounds pressure and saturation temperature in huge caverns hollowed out of solid rock. This hot water would be pumped back to the boilers during periods of high load. To provide ample power storage for a 100,000-kw. plant, the reservoir would be some 60 to 70 ft. in diameter and 100 ft. long. It might be as much as 1,000 ft. below the surface of the ground. A cavern of this type, Mr. Gay estimated, could be excavated at a cost of four or five dollars per cubic yard.

Compared with surface storage in steel accumulators, it is contended that underground storage offers a large saving in first cost per unit volume and a greater heat accumulation for a given volume, because of the higher pressure. "But," one may ask, "will it work?" Here, after discounting the usual objections of those who are opposed to all novel ideas, there remain many legitimate questions.

For example: Will the scarcity of suitable rock formations prevent the general application of this system? Should the cavern be lined or unlined? If unlined, can fissures in the rock be grouted or otherwise closed? Can the pores of the rock be filled in a way that will insure tightness when the cavern is full of water at 2,000 lb. pressure and a temperature exceeding 600 deg. F.? Will the walls be weakened by the solvent action? Will dissolved rock elements cause troublesome deposits in the boilers? These are some of the problems to be faced.

It is true that most of these troubles can be eliminated at one stroke by lining the cavern with steel plates welded together, and perhaps corrugated to provide for expansion and contraction. A steel lining would, however, run up the cost considerably. While relatively thin metal could be employed, the whole surface of the cavern would have to be smoothly finished or grouted to give the necessary backing. The shaft would have to be large enough to admit the widest plates used.

Clearly, underground storage is a many-sided problem. Those studying it would do well to consult practical experts in geology, mining, civil engineering and oil well drilling.

If, on further investigation, some of the difficulties mentioned disappear, while others lend themselves to simple remedies, the system may open new roads to cheaper power generation. It is worth thinking about.

The Public and the Power Utilities

THIS is an age of big business, and new relations prevail in which the public, through widespread investments, has become an important part. Because of this it has acquired an intelligence and a sensitiveness to events that demand sound and constructive direction, through acts as well as words. This applies especially to the utility field, where a growing knowledge of the importance of power in our daily lives has made people power conscious.

Power generation ranks basically as one of the soundest fields of endeavor. It is practically assured of continuous growth and possesses a diversity and a degree of regulation which affords protection against all save general business depression. Not only is power an index of our national prosperity, but it plays an important rôle in fostering it.

It is a pity that it has, of late, been connected with tales of financial manipulation through combinations of companies and pyramiding of the financial structure through holding companies and the like. To the extent that such combinations make for operating economy they are sound. But the street whispers of further combina-

tions, and heads are shaken at the question of where they may be expected to cease.

These fulminations are crystallizing into demands that Congress establish some satisfactory form of regulation. Doubtless, some means of regulating the holding companies must be found which will, however, not retard their normal growth.

Herein lies another difficulty. The work demands the intelligent understanding and experience of experts, men who are technically of highest qualifications. Unfortunately, these attributes seldom go hand in hand with political proficiency.

There are those who, emulating the ostrich, would bury their heads, confident that all is well. But the present is no time for leadership of the ostrich variety. With the early experiences of the railroads in mind, let the public be given facts so that its guiding force may be felt by those in Congress who concern themselves with the problem.

Safety Valves on Hot-Water Heaters

HOW a hot-water heater should be safeguarded against excessive pressure is a subject upon which engineers are not in full agreement. As revealed by answers appearing elsewhere in this number, some feel that the relief offered through the water backing up into the street main is ample, while others claim that a relief valve is necessary.

The question has more than one angle. If a check valve is in the line from the service main, sound judgment dictates the employment of a relief valve. Unfortunately, the presence of the check valve, by isolating the water in the heater, will cause the relief valve to open and remain open as long as gas is burning under the heater and no water is being drawn. This continued blowing of the relief valve will speedily ruin its sealing qualities, and unless the valve is piped to a drain there will always be some water on the floor around the heater. It seems that the solution is the prohibition of a check valve in the service line.

Many water meters have hard rubber wings, which will deteriorate if much hot water backs through them. Then too, there is always the possibility of the water-service cock being closed. Under these conditions a relief valve seems desirable. But a valve that is not raised occasionally will corrode to its seat, so that it will be inoperative at a critical time. Consequently the presence of one is no sure indication of safety.

What is needed is a mechanism that is used frequently enough to insure its working in an emergency. A relief valve of the ordinary type does not meet this requirement, and, as has been outlined, does not contribute to safety. A number of valve manufacturers build faucet valves that embody a spring-loaded disk. These are hand-operated as a simple compression bib-cock, but are raised automatically from their seats by excess pressure and insure automatic operation in time of over-pressure.

The Price of Poor Boiler Plate

"ALL IS NOT gold that glisteneth," nor are all boiler plates what they should be just because they answer the prescribed chemical and physical tests.

Experts were recently called to investigate the drum of a new four-hundred-pound boiler. It was made of $2\frac{3}{8}$-inch plate and after short service showed a number of depressed spots of various depths and areas. The worst was a quarter inch below the surface and about four inches in length measured on the drum axis.

A few hours' work with a hammer disclosed literally hundreds of such spots varying in depth from one-eight to three-sixteenths of an inch. All were caused by an accumulation of scale having been pressed into the plate surface during the hot-rolling operation when the drum was formed.

The A.S.M.E. boiler code permits irregularities of this sort provided that their depth is not more than fifteen per cent of the plate thickness. Thus, in the particular case at hand there was no cause for rejection.

The fact remains, nevertheless, that the purchaser possesses a new boiler in which at least a quarter inch of the useful thickness is dissipated without giving any equivalent in service. It is the purchaser's right to expect better than this in a new boiler.

At first thought the responsibility for the trouble seems to center upon the maker of the drum. Why was the scale not removed from the plate before rolling? There is no doubt that it could have been. The additional expense is what deters.

So then, it is simply a question of whether the purchaser wants the plates free of scale and is willing to pay the price. Specifications may easily be drawn to provide for inspection of the plates and for their rejection unless practically free of depressions.

A comparison of the prices under such specifications, with those offered under the existing regulations, will promptly show whether the refinement is worth while.

By and large, the purchaser generally gets what he pays for.

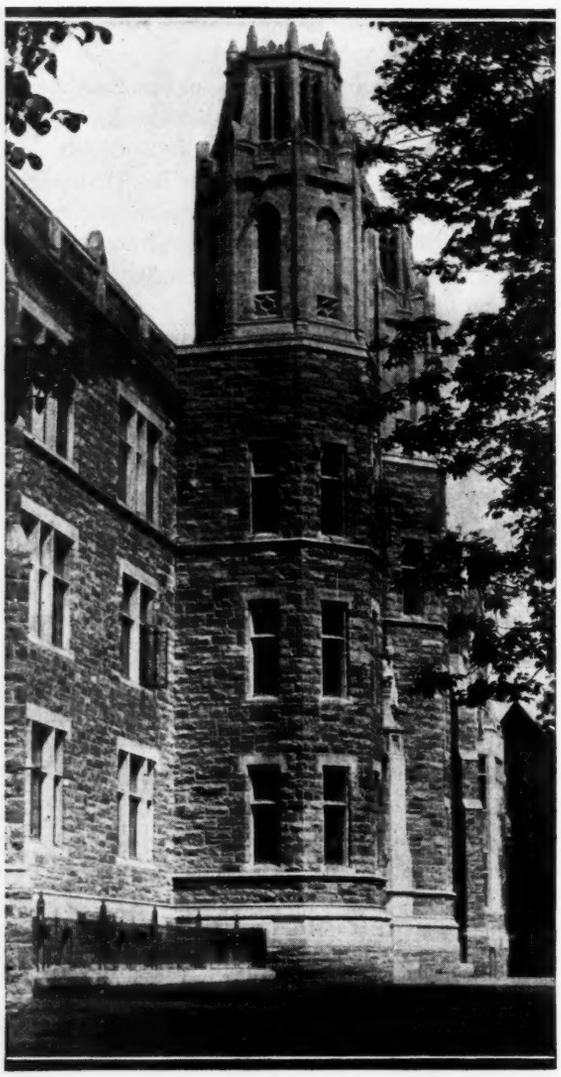
▼

POWER *Stands for . . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

▼

PACKARD LABORATORY at LEHIGH



A fitting memorial to an industrial pioneer

The equipment of engineering schools plays a part second only to the quality of the teaching personnel in determining the effectiveness of our future engineers. It is therefore significant that next fall will see the formal dedication at Lehigh of the most complete laboratory every built for instruction in mechanical and electrical engineering.

A Great Gift To Engineering

THE James Ward Packard Laboratory, erected at a cost of $1,200,000, is now complete, largely equipped and in active use by the 900 engineering students at Lehigh.

Lehigh University, founded in 1866, by Asa Packer, in the old Moravian city of Bethlehem, is close to the great Bethlehem Steel Works, numerous cement plants and silk mills and other industrial plants where students may see the practical interpretation of engineering principles.

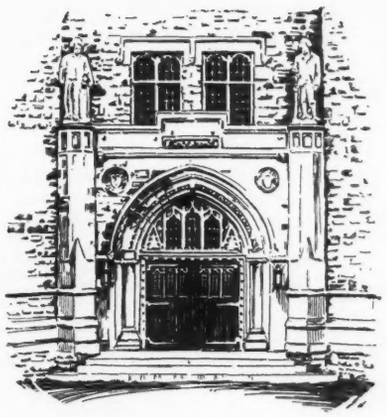
Lehigh differs from most American universities in that it is built around the engineering school. The School of Arts and Science, on the one hand, and that of Business Administration on the other, stand as the fulfillment of Asa Packer's vision of an institution where the engineer should have some first-hand contact with matters outside of his technical specialties.

The fact, however, that the engineering students number approximately 900, out of a total enrollment of 1,500, indicates the predominant engineering aspect of Lehigh. The following engineering courses are given: chemistry, chemical engineering, civil engineering, electrical engineering, engineering physics, industrial engineering, mechanical engineering, metallurgical engineering, and mining engineering. In all of these fields Lehigh men—teachers and graduates—have done noteworthy work.

Upon the retirement of President Henry Sturgis Drinker in 1922, Lehigh trustees took a far-reaching step destined to maintain and enhance the prestige of the university. From the Middle West, Charles Russ Richards, dean of engineering and director of the experiment station at Illinois, famous for his contributions to engineering education and for his building and administration of great laboratories, was called as president. Fortunately, an engineer was chosen as chief executive of the university whose interests lie preponderantly in this field.

Following sound engineering procedure, President Richards' first act was to initiate a broad survey of

Lehigh's personnel, physical needs, and possibilities. The need for far more laboratory facilities in electrical and mechanical engineering became immediately evident. No money for a building project was on hand or in sight, but President Richards boldly stated the need to the alumni and friends and laid before them in detail his conception of a suitable establishment. This proposal fortunately came into the hands of an outstanding Lehigh graduate, the founder of a great industrial establishment. James Ward Packard, Lehigh graduate of 1884 and founder of the Packard Motor Car Company, offered $1,000,000 in a lump sum to transmute President Richards' dream into a reality.



Statues of Michael Faraday and James Watt adorn the main entrance

After formal acceptance of this offer, President Richards organized a group consisting of himself; the architects, Messrs. Theodore Visscher and James Burley, of New York City; F. V. Larkin, head of the mechanical engineering department; M. C. Stuart, professor of experimental mechanical engineering; William Esty, deceased (then head of the Department of Electrical Engineering); and S. S. Seyfert, professor of electrical engineering, to study existing college laboratories and to perfect plans for a building and equipment to meet the needs of the university in the best manner. Yale, Harvard, M.I.T., Worcester Polytechnic, Rensselaer and Cornell were visited in the East, after which the group surveyed the laboratories of such great Mid-West institutions as Michigan, Northwestern, Wisconsin, Illinois, Minnesota, Purdue, Cincinnati, Pittsburgh and Carnegie Tech.

Then came a year of intensive planning, and finally the breaking of ground in April, 1928, and completion of the building, except for equipment, early in 1929.

The Packard Laboratory is in the form of a hollow rectangle built on a hillside. A large laboratory bay three stories high lies parallel to and facing Packer Ave. on the downhill side. The other three sides of the quadrangle contain offices, class rooms, private laboratories, research rooms and many other special rooms required for the various purposes of the department.

The main entrance is on the uphill side of the building. This interior frontage, together with that of the great Memorial Building, the new library, Packer Hall and Packer Memorial Church, form a consistent architectural unit in the shape of a quadrangle. The outer dimension of the Packard Laboratory, which varies in height from three to five stories, are 160 ft. x 220 ft.

Four things stand out prominently in the mind of one who makes a casual inspection of this magnificant building. First, is an architectural treatment of real beauty, with soft-toned outer walls of native stone flanking an entrance appropriately adorned with the figures of James Watt and Michael Faraday. The trim is of Indiana limestone.

The second outstanding feature is the division of the building into two symmetrical halves, devoted, respectively, to housing the complete departments of electrical and mechanical engineering. The third is the shape, size and general construction of the main laboratory, of which more will be said. The fourth is the extent to which provision has been made for almost every conceivable activity of professors and students in these departments. Another

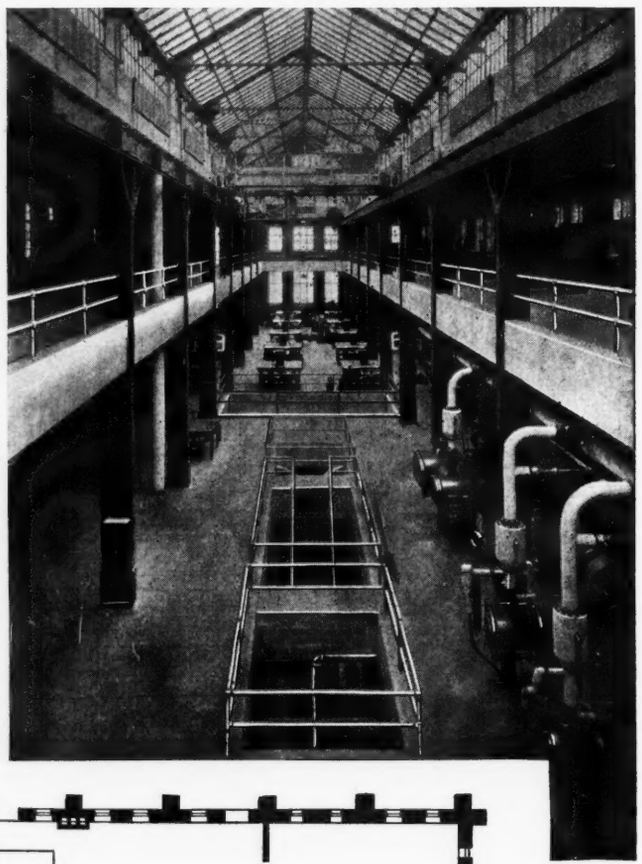
Mechanical engineering occupies the right wing, electrical the left. On the far side—down the hill—is the large laboratory bay

feature of considerable interest is a magnificent auditorium in the well formed by the four sides of the quadrangle. This has a seating capacity of over 600. The general appearance and arrangement of the large laboratory will be clear from the illustrations. This is a three-story bay 60 ft. x 220 ft. with a height of 52 ft. from the basement floor to the top of the monitor roof, which extends its entire length. A 10-ton traveling crane serves the entire length of the second and third floors and, through wells, certain portions of the basement. The third floor is a simple gallery 20 ft. wide completely encircling the central bay. It is devoted largely to exhibitions of general engineering interest, although space will be allotted to general laboratory and research work as required.

The second floor, which is the main laboratory floor, contains, on the electrical engineering side, the main dynamo laboratory. This is notable for the flexibility of its arrangements. Standard connection plates on motor and generating units and on testing tables, together with flexible plug connections and sector-type water rheostats beneath the tables, permit innumerable varieties of connections and reduce the time required for the purely mechanical part of the experimental work.

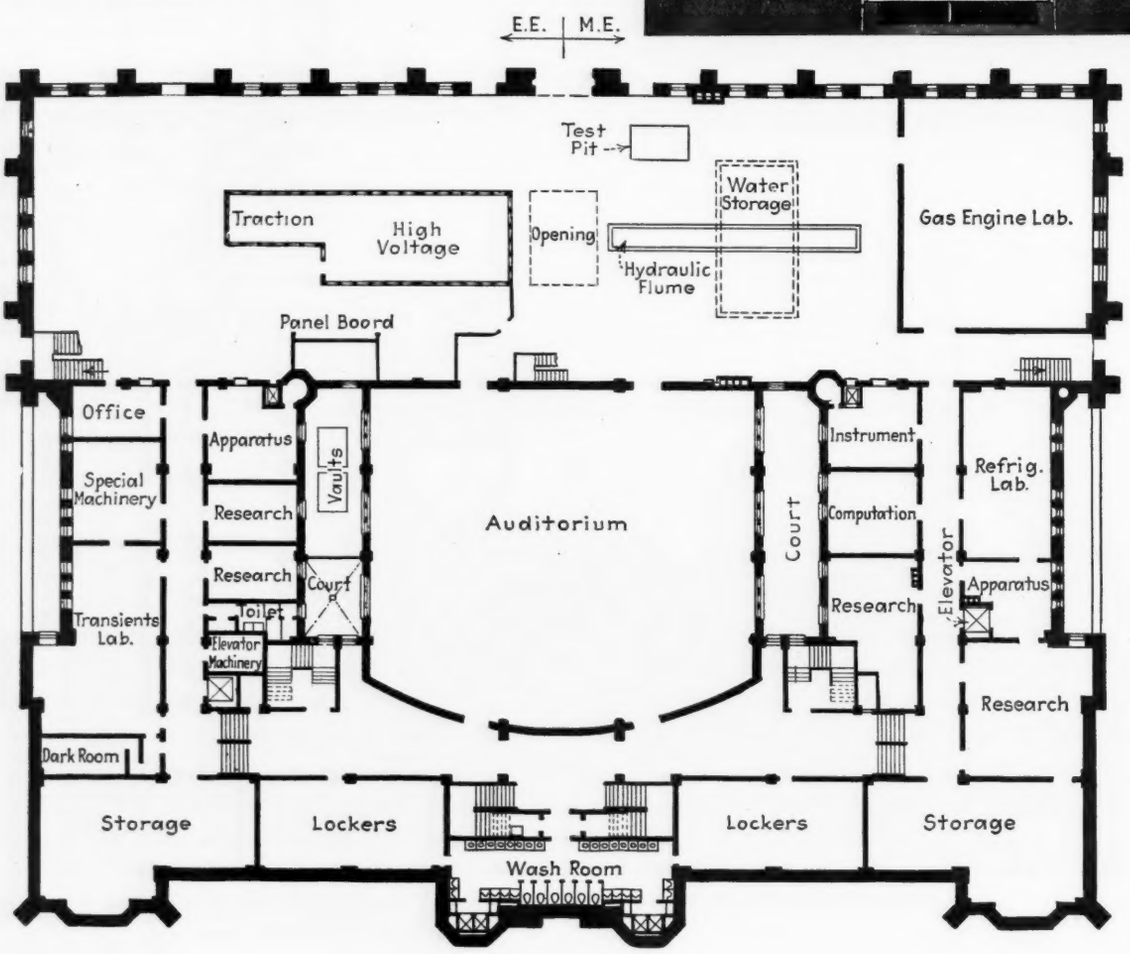
A switch and plug box of a type especially designed for this laboratory is placed on the center of each work table and connected through conduits to wall switchboard and plugboard. It is an invariable rule that the student must plug his own connections from one part of the wall switchboard to another and from his work table plug and switchbox to his electrical apparatus.

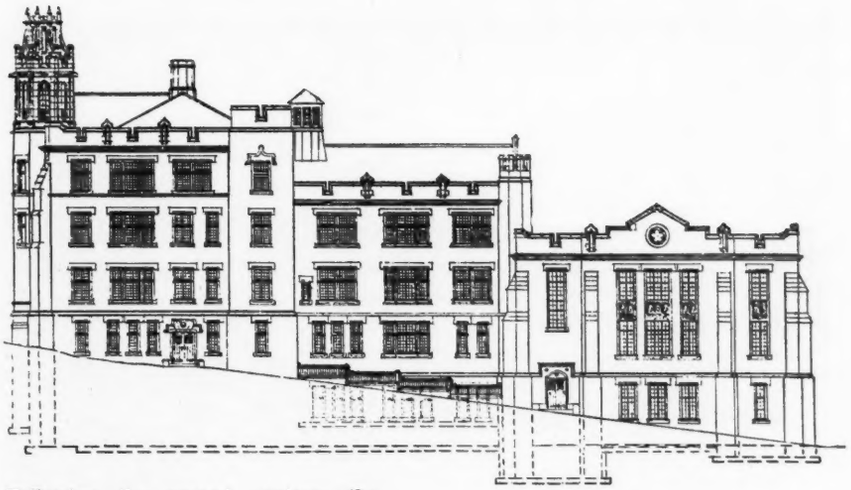
At the mechanical end of this floor is located the steam laboratory, one side of which is devoted to recip-



The main laboratory bay is 220 ft. long and 52 ft. high from basement to monitor top

First floor plan. Main entrance, shown at bottom of page, faces inward and up hill





Following the ground contour, the building slopes down to the street. Main laboratory bay at the right

rocating units, as shown on page 544, and the other to turbine units. The latter are yet to be installed. Condensers, pumps and water-measuring flumes are immediately below the engine floor. Of particular interest among the reciprocating units is a compound steam-driven air compressor capable of delivering 850 cu.ft. of air per minute against a pressure of 125 lb. Both intake and delivery are muffled by connection to vertical, tile-lined stacks in the walls.

Lehigh is fortunate in having a marine type triple-expansion engine. This is shown at the left of the reciprocating group on page 544.

It is the definite policy of the Mechanical Engineering Department that, other things being equal, a small unit is better for laboratory purposes than a large one. The equipment installed meets this criterion.

As a center for welding conferences, Lehigh has recently assumed an important position. It is therefore fitting that welding has been extensively applied in the fabrication of piping for the new laboratory.

The internal-combustion engine laboratory, located on the ground floor, for the double purpose of permitting foundations independent of the building proper and of insuring easy handling of equipment, is entirely housed-in to minimize odor and noise. All engine exhausts are connected to a system which passes underneath the floor, then through an exhaust fan and finally into the atmosphere through a 30-in. stack concealed in one of the masonry towers of the building. This laboratory, nearing completion, houses three Diesel engines (two of which are connected to a common water brake), a gas engine, a small electric dynamometer unit and a battery of eleven automobile motors arranged to connect to a movable electric dynamometer of 150-hp. capacity.

Plans for the refrigeration laboratory, to be completed this summer, call for a 10-ton ammonia plant for laboratory instruction and for a combined ammonia and CO_2 plant for research work, with cold rooms capable of maintaining temperatures as low as 25 deg. F.

Each department is provided with three instrument rooms, one serving each floor of each laboratory.

Instruction in shop practice has never formed a part of Lehigh's engineering curricula. As no shops for such instruction are provided in the new laboratory, it is apparent that there is no intention of incorporating such instruction in the future. Preparation is made, however, for research work on machine tools by the provision of adequate space for it.

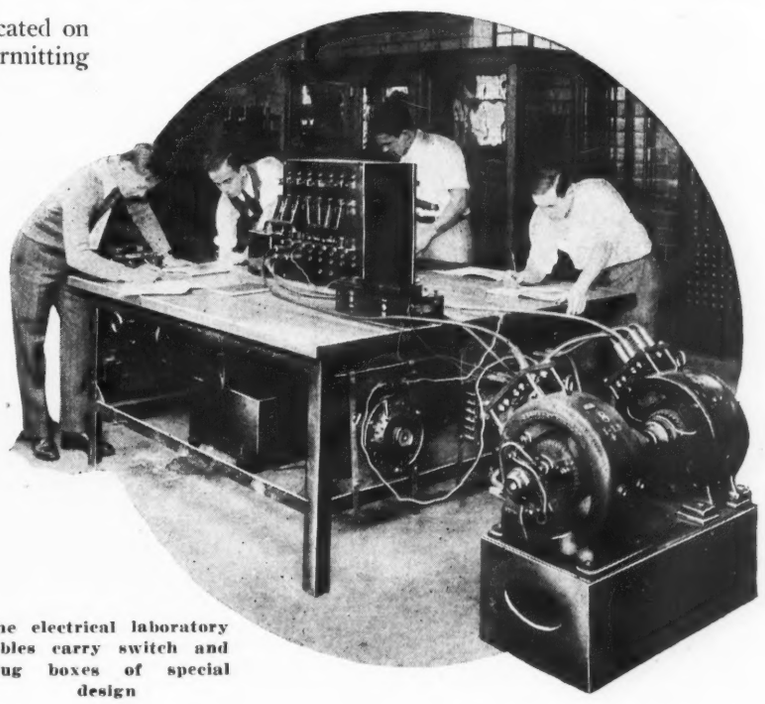
Because the university library, recently remodeled to five times its former capacity, is conveniently close, there is no branch library in the new laboratory. Both departments, however, maintain reading rooms.

On the second floor is a smoking room for the common use of students. Kitchens at both ends of this room provide each of the students' engineering societies with facilities for serving refreshments following meetings.

The furniture throughout the building is in keeping with the structure itself. Desks, tables and bookcases are of steel construction. All office, laboratory and reading-room chairs are of aluminum. Drawing desks, designed at the university and manufactured as the "Lehigh drawing desk," are unique in that each can accommodate four men working in pairs at different hours and that each man, with one padlock, can isolate his board compartment, paper drawer and instrument drawer from those of his neighbors.

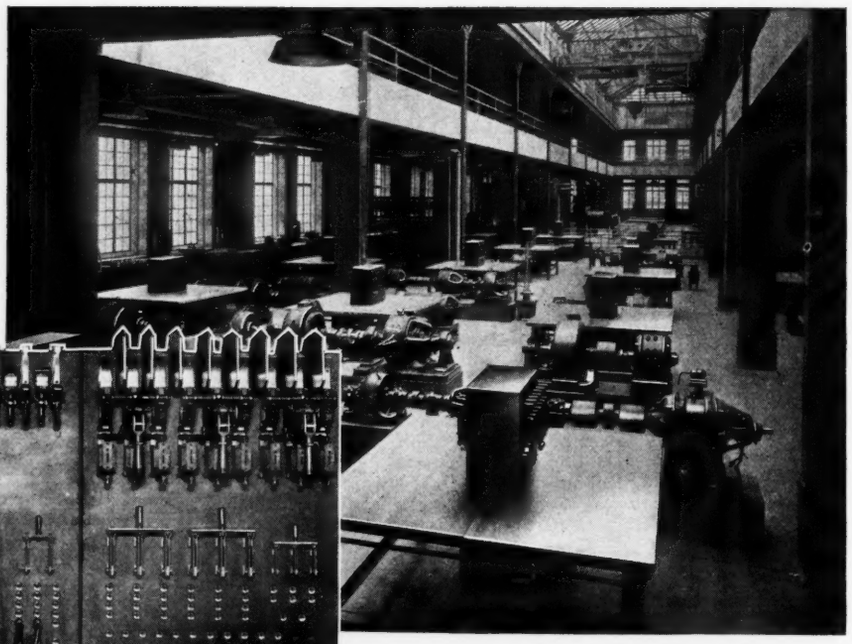
No coats hang in the halls of this building. Rooms off the main corridors in the vicinity of class and lecture rooms are fitted with hooks for coats and substantial railings for hats and books.

In the main building each of the four floors above the basement is equipped with one or more offices for the teaching staffs, and with numerous research rooms.

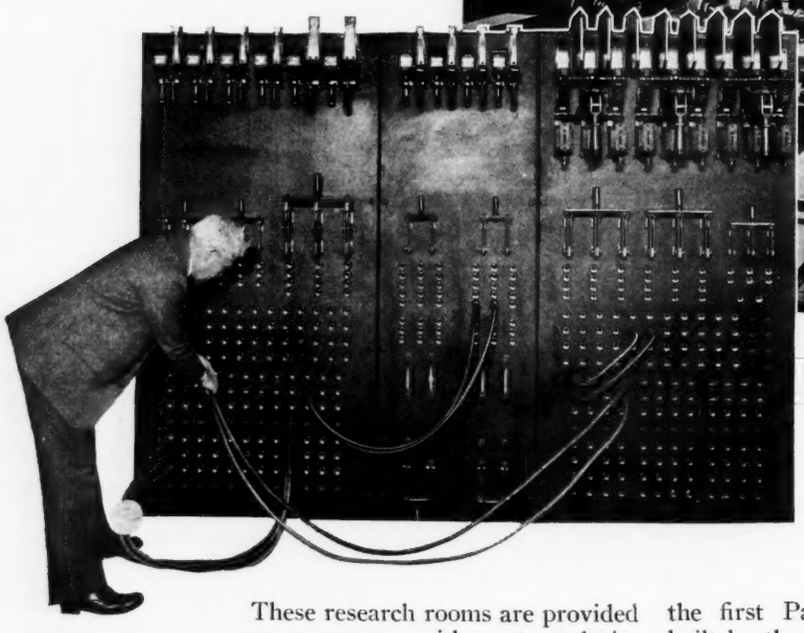


The electrical laboratory tables carry switch and plug boxes of special design

Main laboratory floor from the electrical end

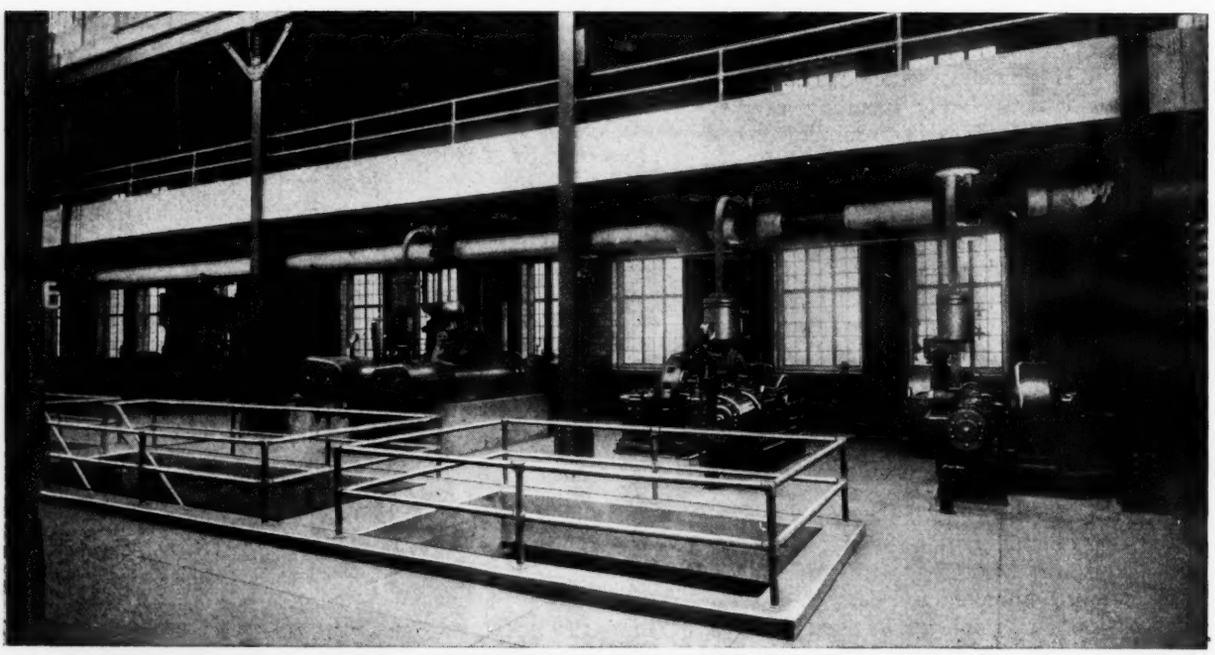


Section of large plug board in electrical section of main laboratory



These research rooms are provided as necessary with water, drain, compressed air, gas and electricity. By means of electric circuits terminating at central plug switchboards, any type of current (alternating current, direct current, or storage-battery current) from 6 volts to 220, direct current, and from 110 to 440 volts alternating current, one-, two-, or three-phase, is made available in these rooms.

The dedication of this splendid addition to the engineering laboratories of the country will take place on Oct. 15, 16 and 17, 1930, with an elaborate and appropriate ceremony participated in by the engineering colleges and the industries of the country. At that time the first Packard car—a "one lunger" designed and built by the donor of the building—will be driven overland from Detroit under its own power by a Lehigh man to its final resting place in a glass case in the lobby of the building which it made possible. There it will stand as a perpetual inspiration to future generations of Lehigh men.



Reciprocating steam driven units include a new compound two-stage air compressor, shown just left of the center

REBUILT POWER PLANT

of Algonquin Printing Co.

SAVES BYPRODUCT POWER, FUEL AND LABOR

TO MEET the new competition many New England manufacturing plants are modernizing their power equipment. A fine example of a complete changeover may be found at the Fall River (Mass.) works of the Algonquin Printing Company, which specializes in the printing of cotton textiles.

Up to last year steam for process was generated at 100 lb. pressure in hand-fired return-tubular boilers. In spite of the large steam demands, typical of all textile printing plants, no byproduct power was generated. All power used in the mills was purchased.

Installation of an entirely new plant for the generation of steam and power was started late in 1928 under the supervision of I. Hallas, plant engineer. The return-tubular boilers were gradually replaced by an improved type of Scotch boilers, oil fired. The sixth and last boiler is now ready to go on the line. The boilers operate at high efficiency, generating steam at 200 lb. gage and 100 deg. superheat. They supply steam to turbine units generating both alternating and direct current, and exhaust to process at 15 lb. gage.

Excess exhaust steam, normally required at all times, is supplied from the boiler mains through reducing valves.

Generation of power began in July, 1929, at the rate of approximately 1,500,000 kw.-hr. per year. Steam requirements vary from month to month and from year to year. At present the demand is around 800,000 lb. for the ten-hour day and 200,000 lb. for the fourteen-hour night.

New equipment installed is covered in the accompanying table, but it will be well to give a brief survey of the plant, stressing certain points of particular interest.

Installation of Scotch boilers with superheaters is unusual. The modified type of Scotch boiler selected (Fig. 3) gives large storage capacity for the sudden demands of a textile plant. Refractory and air leakage troubles are eliminated. Efficiencies as high as 78 per cent have been obtained in the Algonquin plant. A heavy oil, "Bunker C," is used in mechanical-type burners.

The boilers are lagged with 4-in.-thick insulation and are amply provided with boiler meters, draft gages, feed regulators, etc. Because of loss of steam in the processes,

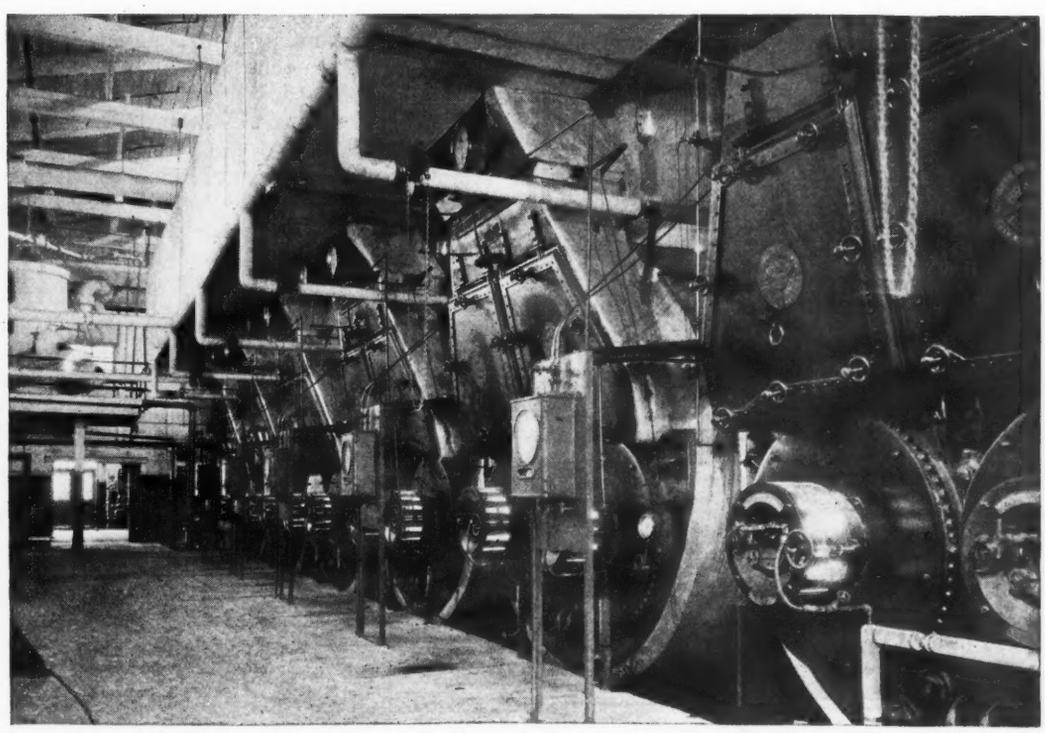


Fig. 1 — Oil-fired Scotch boilers with upper drums give ample heat storage for sudden steam demands

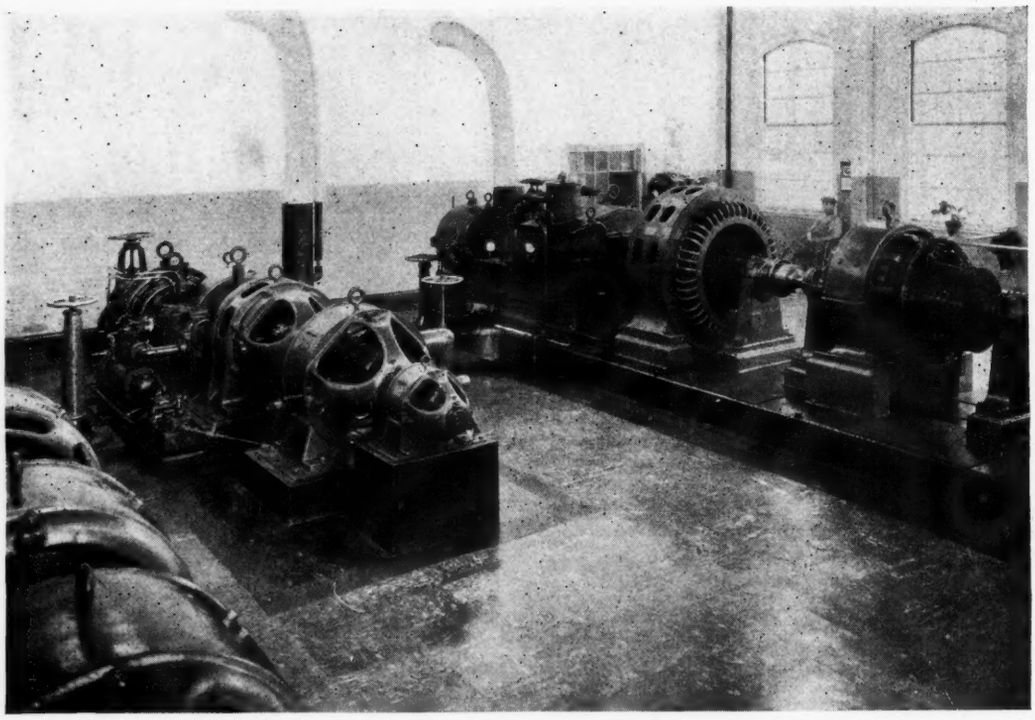


Fig. 2—In the well-lighted turbine room are three geared units exhausting to process

only about 50 per cent of the process steam is returned as boiler feed, so that the quality and treatment of the make-up water is a matter of considerable importance. The make-up supply flows to the Algonquin plant by gravity from Cook pond. This supply is fairly soft and neutral, but slightly turbid. To remove turbidity it is treated with alum and passed through a sand filter. It is then passed through a zeolite softener.

Through float-controlled valves the make-up is brought to the returns tank from the filtered-water storage tank. It is then lifted by a turbine-driven booster pump to the deaërating open heater.

The main source of power in the day time is a turbine geared to two generators, a 500-kw. alternating-current and a 250-kw. direct-current. Night load is carried by a similar unit driving a 100-kw. alternating-current generator and a 50 kw. direct-current generator. A 37½-kw. turbine unit takes care of the Sunday load.

A balancer set used in connection with the 250-volt generator is of particular interest. Three armatures on a single shaft are wired for 60, 80 and 110 volts, respectively. Various combinations of these make possible 24 different speeds on the printing machine drives. With each step advance of the controller handle the speed is increased seven per cent. The voltage steps are 60, 80, 110, 140, 190 and 250. For each voltage notch there are three field resistance notches, making the total of 24 positions already mentioned.

All turbines exhaust at 15 lb. to the process mains. Additional process steam at present is reduced to 100 lb. in the boiler room and carried to manufacturing departments before final reduction to 15 lb. Provision is now being made, however, to effect complete reduction in the process departments.

While the Algonquin Printing Company does not care to release the actual figures of cost and savings, they say that the investment is yielding a very satisfactory profit.

It was, unfortunately, impossible to obtain a satisfactory photograph of the entire turbine room, showing all units, the large switchboard and the travelling crane. Rubber-tiled floors, high windows, white-painted walls, and spotless cleanliness are features of this room that attract the eye of the visitor. Almost automatically they insure proper attention to maintenance, which, in turn, means increased reliability.

The alterations were carried out under the direction

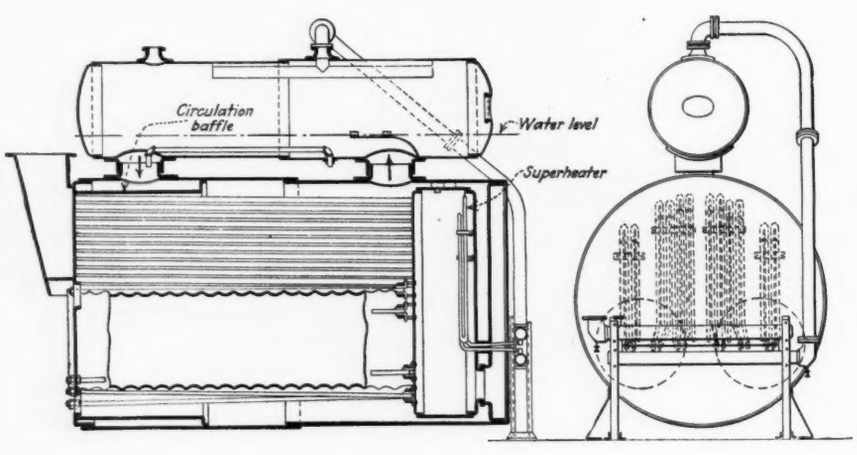


Fig. 3—In the Scotch boilers the arrangements to improve circulation and the placing of the superheater are of particular interest

Principal New Power Equipment Installed in Algonquin Plant

Boilers

Number 6
Type..Brady Scotch with upper drum and double furnace, internally fired
Manufacturer..... International Engineering Works
Heating surface per boiler, sq.ft..... 3,000
Steam pressure, lb. gage..... 200
Superheat, deg. F..... 100

Superheaters

Type and location, Elesco, 12-unit, in rear combustion chamber
Manufacturer ..... Superheater Co.

Oil Firing

Outside tank, coil-heated, capacity, gal..... 35,000
Oil pumps ..... Warren duplex
Heaters, 2...Whitlock fuel oil heaters, multiple pass type
Grade of oil, "Bunker C," 14 to 15 Bé at 60 deg. F.
Burners per boiler 2
Type and pressure, mechanical, 160 lb. max.
Manufacturer ..... E. L. Woollev & Co.

Boiler Equipment

Soot blowers, number and location: 2 heads per boiler, in rear combustion chamber.
Manufacturer..... Diamond Power Specialty Corp.
Stop valves ..... Pratt & Cady
Non-return valves..... Ruggles Klingemann Mfg. Co.
Stop and non-return valves on No. 6 boiler ..... Lunkenheimer Co.
Feed-water regulators ..... Wright Austin Co.
Water columns (with high and low water alarms) Wright Austin Co.
Blow-off cocks and valves..... Homestead Valve Mfg. Co.
Safety valves, 2 per boiler Consolidated Ashcroft Hancock Co.

Feed-Water System

Percentage make-up, less than 50 per cent
Make-up supply, by gravity from Cook pond
Quality, fairly soft and neutral, but slightly turbid
Make-up water pump, centrifugal, 160 gal. per min. motor-driven
Manufacturer ..... Allis-Chalmers
Treatment, alum, sand filter, zeolite softener
Manufacturer ..... Hungerford & Terry, Inc.
Returns-receiving tank, float-controls make-up from storage of filtered water
Booster pump to feed heater, Goulds centrifugal, driven by Carling turbine
Deaërating open heater..... Elliott Company
Boiler-feed pump, Goulds centrifugal driven by Westinghouse turbine
Stand-by feed pump ..... Warren duplex

Turbine Room

Number of turbine-generators..... 3
Manufacturer..... Westinghouse Elec. & Mfg. Co.
Throttle conditions, 190 lb. gage and 90 deg. sup.
Back press, lb. gage..... 15
Large unit, 4,885-r.p.m. impulse turbine geared to 1,200-r.p.m. shaft carrying 500-kw. a.-c. generator and 250-kw. d.-c. generator.
Second unit (for night use), 6,600-r.p.m. impulse turbine geared to 1,200-r.p.m. shaft carrying 100-kw., a.-c. generator and 50-kw., d.-c. generator
Third unit (for Sundays), 1,800 r.p.m., direct drive to 37½-kw. a.-c. generator
Balancing unit..... Allis-Chalmers
Crane, 8-ton..... Henry B. Newhall Corp.

Process Steam Regulation

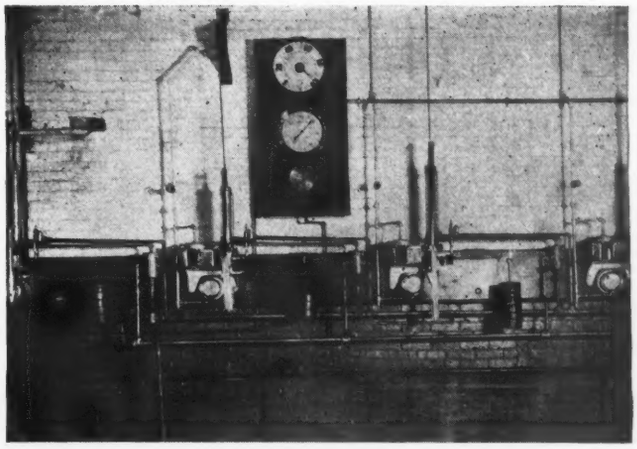
15 lb. lines to departments from turbine exhaust
100 lb. lines to departments, reduced from boiler pressure through Ruggles Klingemann control. Pressure reduced to 15 lb. in departments. This will be replaced by direct reduction to 15 lb. in boiler room.

Instruments and Regulators

Boiler meters, 6, steam-flow, air-flow, flue-temp. draft
Manufacturer ..... Bailey Meter Co.
Draft gages, 6..... Republic Flow Meters Co.
Steam gages..... Consolidated Ashcroft Hancock Co.
Feed-flow meter..... Republic Flow Meters Co.

Miscellaneous Equipment

Service pump, 750 gal. per min. (at 75 lb.) Warren centrifugal driven by Westinghouse turbine.



These regulators work in conjunction with balanced valves to reduce 200-lb. steam for 100-lb. process lines

of E. I. Marvell, architect and engineer of Fall River. All units installed were selected by I. Hallas, the plant engineer, after an extensive tour in which he studied various types of equipment under textile mill conditions.

To Mr. Hallas and his son and assistant, John Hallas, *Power* is indebted for the opportunity to inspect the plant and for making available data on its operation.

Selecting Belt Drives for Profitable Production

By Joseph Rhoads

THERE are three points to which special attention must be given in selecting belts. First, the belting should have high transmission efficiency. This depends upon what is technically known as coefficient of friction. A common term for it is pulling grip, that is, capacity for transmitting power from pulley to pulley. The belt should be almost free from positive slippage, though always subject to slight loss from creep. The combined slip and creep of much belting will run 2 or 3 per cent, whereas a leather belt of best modern tannage on the same machine under normal load will show, at most, about 1½ per cent—likely nearer 1 per cent.

The second important point in selecting a belt is to get one so thoroughly stretched that it will show little stretch on the pulleys. The main advantage of this is that a stretchy belt will probably become so slack that slippage will cause loss before it is noticed. A well-stretched belt eliminates frequent take-ups and consequent loss of time.

The third point is to select belts that will give long service. This used to be considered next to price before the difference in transmitting capacity was scientifically studied. Frequently belts with the highest pulling grip will also show the longest life on difficult drives; often lasting more than twice as long as less efficient belts, and thus actually costing less per year. But this is not always the case. It is possible to tan leather so as to give high pulling grip without producing the most lasting belts. The prudent belt buyer naturally learns of the experience of others where possible; or he tests the claims of belt manufacturers by a trial belt.

It does pay, before discarding mechanical transmission, to ascertain what results are obtainable with well-planned layouts using the best of leather belting.

How to Select

MAGNETIC CLUTCHES

By W. H. COSTELLO
Engineer,
Cutler-Hammer, Inc.

Magnetic clutches are generally considered power transmission equipment, but they may be used to good advantage for power-factor correction with synchronous motors, adjusting machine or motor capacity to suit the demand; as an unloader on air compressors and on accumulator pumps; as safety devices; and for many other services.

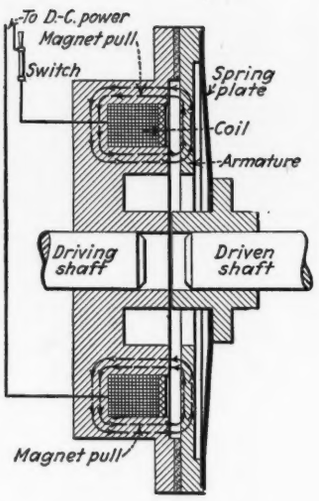


Fig. 2—Magnetic clutch engaged

CLUTCHES are used for a wide variety of applications to connect and disconnect machines from their source of driving power. They are made in two general forms: magnetically operated and mechanically operated. To engage or disengage a magnetic clutch it is only necessary to open or close an electrical circuit. This type of clutch may be operated by a push button from any one of several locations and controlled automatically by a float switch, a pressure regulator, a speed governor, a temperature regulator or any other form of remote control. The clutch may be located any distance from the control, as it is only a matter of running an electric circuit between the two. These features, together with its simple construction, ease of adjustment and small space requirement, have won a prominent place for magnetic clutches in power transmission.

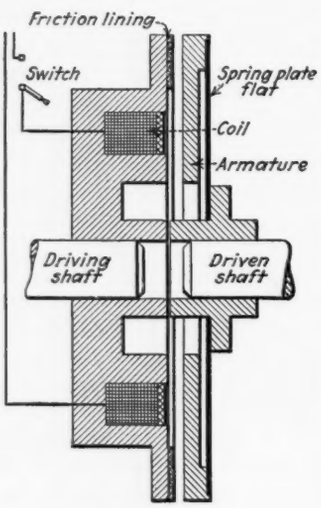


Fig. 1—Magnetic clutch disengaged

Fundamentally, a magnetic clutch is a friction type, in which the pressure between the clutch members is developed by an electromagnet. The action is illustrated in Figs. 1 and 2. The magnetizing coil is in the field or driving member of the clutch and the friction lining surrounds the field. When the coil is energized it pulls the armature or driven member up against the lining, Fig. 2, which produces the driving torque. The armature plate drives through a steel disk that deflects sufficiently to allow the two surfaces of the clutch to engage, thereby eliminating sliding surfaces.

The friction faces are practically the only wearing parts. There is a chance to wear the pilot bearing between the two members, but with an oversized anti-

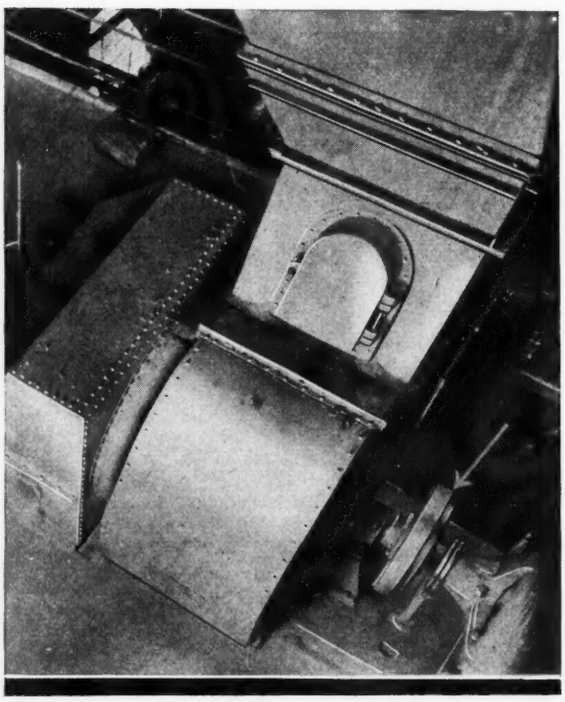


FIG. 3—TWO MOTORS DRIVE AN INDUCED-DRAFT FAN, ONE THROUGH A MAGNETIC CLUTCH

For slow-speed operation the fan is driven by a comparatively small motor coupled directly to its shaft. For high-speed service the small motor is disconnected from the line and a large high-speed motor is connected to the fan by a magnetic clutch.

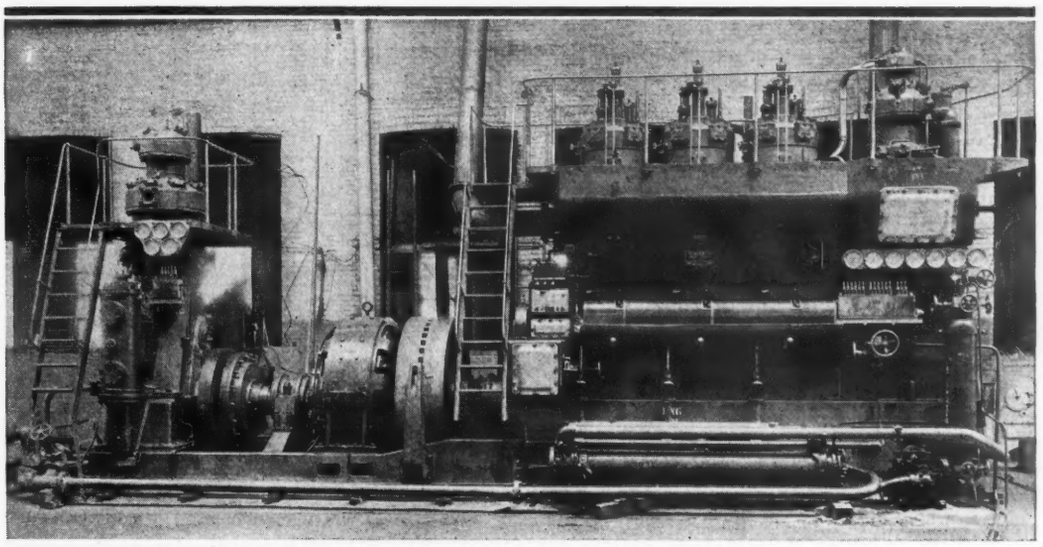


Fig. 5 — Magnetic clutch between air compressor and generator driven by Diesel engine

friction bearing it is rarely that failure occurs in this part.

Being mounted on the outside periphery, the friction lining is easily accessible for adjustment by means of screw plugs. The friction ring is made in segments and can be easily replaced without disturbing other parts.

The size of a magnetic clutch required for a given application depends upon the horsepower or torque to be transmitted; the shaft speed; and the energy due to slipping that the clutch must absorb.

As a measure of horsepower-transmitting capacity, magnetic clutches are rated in terms of torque in pound-feet. For example, the 16-in. clutch has a rating of 732 pound-feet. To select the size of the clutch required, it is first necessary to determine the torque of the driving shaft. For the majority of applications the torque can be figured from the horsepower and speed by the formula:

$$Torque = \frac{5{,}252 \times Hp.}{R.p.m.}$$

This formula may not apply where there is a flywheel between a motor and the load. If the clutch is to be installed between the flywheel and the load, its torque capacity will have to be figured from the characteristics of the load rather than from the motor's rating. In cases of this kind, the clutch will generally have to transmit high peak loads of short duration. It is because of these exceptions that clutches are rated both in torque and in horsepower at 100 r.p.m. The latter should not be used for selections of clutches for drives which use flywheels.

The factor of safety to allow when selecting a clutch depends upon the nature of the load. A centrifugal pump load can be closely predetermined, and a minimum factor of safety is permissible. A factor of safety of 100 per cent is sufficient to take care of slight misadjustment or small overload conditions. On the other hand, there are paper mill applications where the starting torque may equal 10 times the running torque. For most applications it will be safe to select a clutch of 100 per cent overload capacity, with about twice the rated full-load torque of the motor.

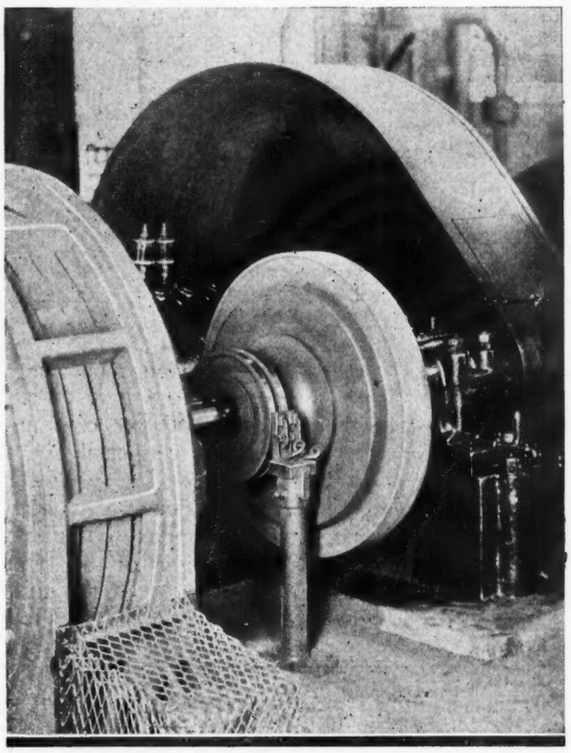


Fig. 4—Magnetic clutch replaces unloader on a motor-driven accumulator pump

Friction Lining Area

Wear on the clutch lining depends upon the slippage, and is determined by the speed, frequency of engagement, and the inertia of the parts to be accelerated. When selecting a magnetic clutch a balance must be obtained between torque capacity and lining capacity. To take care of widely varying requirements, each standard-size clutch is made in three arrangements to allow various ratios between torque capacity and area of lining surface. For slow speed and infrequent starting a clutch of a given size can be supplied with a high horsepower rating and relatively small lining surfaces. When the same size clutch is to be used for high speed and more frequent starting it will have a reduced horsepower rating but its lining area will be increased.

Direct current is always required for magnetic clutches, but the amount is small. For example, a 36-in. clutch which would be used with a 150-hp. motor on ordinary applications takes only 480 watts maximum.

Magnetic clutches to operate on alternating current have never been offered for commercial work, because their cost would be so high as to make it more economical to use a direct-current type with a small generator.

Magnetic clutch operation is not affected by centrifugal force, and the only speed limitations are the stresses in the materials of construction and the feasible perfection of balance. The standard construction is designed for a maximum of 7,500 ft. per minute peripheral speed. By special machine work and balancing, clutches of the same essential design can be rated up to 10,000 ft. per minute on the outside rim.

The question is often asked, will a magnetic clutch take care of shaft misalignment and eliminate the necessity of a flexible coupling? There frequently is misunderstanding regarding the function of the spring plate in this respect. The standard clutch is not intended to take care of excessive misalignment. This is also true of flexible couplings, if they are to give long service. Excessive misalignment of shafts causes relatively rapid wear of either a clutch or a flexible coupling. The permissible shaft misalignment for a standard clutch is 0.01 in. With substantial bearings and foundation, the clutch should run smoothly within that limitation. For ordinary installations it is as easy for the maintenance department to keep shafts lined with 0.01 in. as it would be for greater tolerance. There are hundreds of clutches in satisfactory operation without any provision to take care of shaft misalignment.

If shafts are too much out of line, there will be vibration, which is a warning that shaft misalignment exists and should be corrected. The standard magnetic clutch will operate without a flexible coupling provided the shafts are supported in four bearings on a good foundation.

A pilot bearing is built into the clutch to insure concentric engagement of the members. A roller bearing with both radial and thrust capacity is mounted on a projection of one member and engages in a cup in the other member. The weight of the shaft might be sufficient to deflect the clutch members and cause eccentric engagement while the clutch is accelerating. It is not always possible to provide short, sturdy pedestals for the shafting, and pedestals or hangers are used that are not as rigid as they should be. Under these conditions a centering bearing will insue that the clutch during engagement does nothing to cause flexing of the bearing pedestals or hangers.

Where foundations are not solid, or on some change-over jobs, it may be difficult to keep shafting aligned. Such installations are the exception rather than the rule. Or it may be that the driving or driven shaft has an end thrust for which allowance must be made. There a combined magnetic clutch and flexible coupling can be supplied that will allow for both parallel and angular misalignment. A construction of this type is not as accessible for adjusting or replacing parts as the individual clutch. Wherever possible it is preferable to arrange the shafting so that the flexible coupling and the clutch can be separate, and use standard equipment that is accessible for inspection, maintenance and renewal of worn parts.

Two unusual service conditions which might be mentioned are high temperature and excessive moisture. The former has to be considered in connection with boiler draft fans. The coil in the standard clutch is designed for an ambient temperature of 40 deg. C. (104 deg. F.). If the temperature of the surrounding parts or the air is considerably in excess of that figure it is necessary to use insulation that will stand high temperatures. The standard magnetic clutch is moisture-proof in the ordinary sense, but it should not be subjected to dripping water. If the latter condition exists the clutch should be equipped with marine fittings.

Because of the inherent features of remote control and high permissible operating speed, magnetic clutches are used on a wide variety of applications, such as fans, pumps, generators, etc.

An interesting application of magnetic clutches used for induced-draft fans in a large central station is shown in Fig. 3. For ordinary boiler loads a 175-hp. motor drives the fan, but as the demand on the boilers increases, by means of automatic control a high-speed 400-hp. slip-ring motor is connected through a magnetic clutch and takes care of the fan load while the high demand exists. With slip-ring motors it is difficult to get stable speed control at below 50 per cent normal. With two motors the speed range can easily be made 3 to 1, using a relatively small motor for the lower fan speeds. There is also a saving in power that would be wasted in the resistance of the secondary circuit if only one motor were used. For applications of this type it is well to check the operating temperature of the clutch so that if necessary provision may be made for unusual conditions.

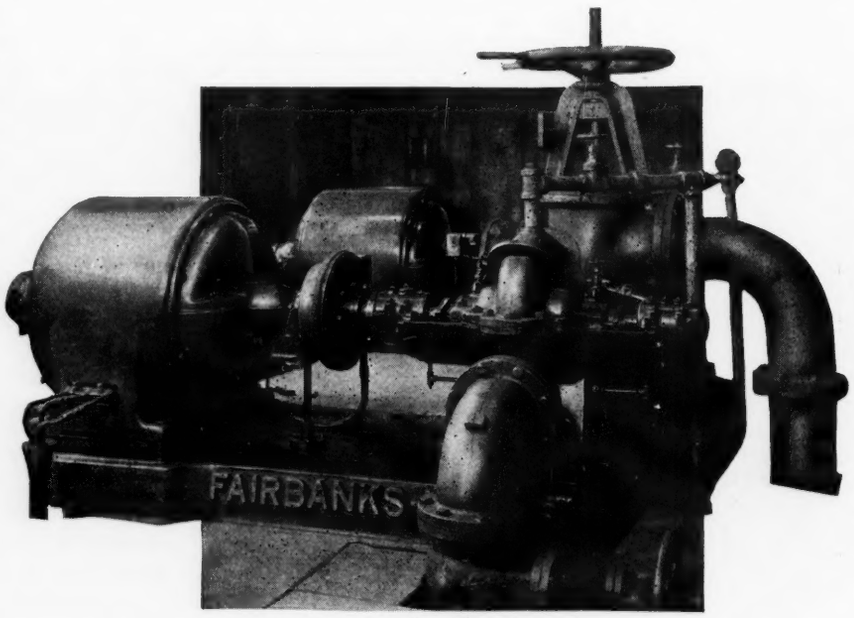


Fig. 6—Synchronous motors connected to centrifugal pumps by magnetic clutches

Another form of dual drive for fans is that used for the Liberty Tunnels at Pittsburgh, Pa. Each fan is equipped with a high-speed and a low-speed motor, each connected through a magnetic clutch. Either of the motors may be used to drive the fan, depending upon the ventilation requirement. Not only is this economical

in power, but it also insures one motor being available should the other fail.

Dual drives for stand-by purposes offer a number of possibilities. For example, a mine fan might normally be driven by a synchronous motor but a steam engine retained for operation of the fan in the event of power failure. Here clutches are used to select the drive required. Likewise, for boiler-feed pumps there may be provided both a steam turbine and a motor with a clutch between the turbine and the pump.

A synchronous motor connected by two magnetic clutches to two direct-current generators represents another application. By means of the clutches either one or both of the generators can be connected, depending upon the demand for direct current.

Fig. 4 shows a combination of a synchronous motor, magnetic clutch and accumulator pump. The starting and stopping of the pump through the magnetic clutch is controlled from a limit switch operated by the rise and fall of the accumulator. Instead of using unloader valves and keeping the accumulator pump running continuously, the pump is stopped by the limit switch de-energizing the clutch, thereby saving wear and tear on the pump.

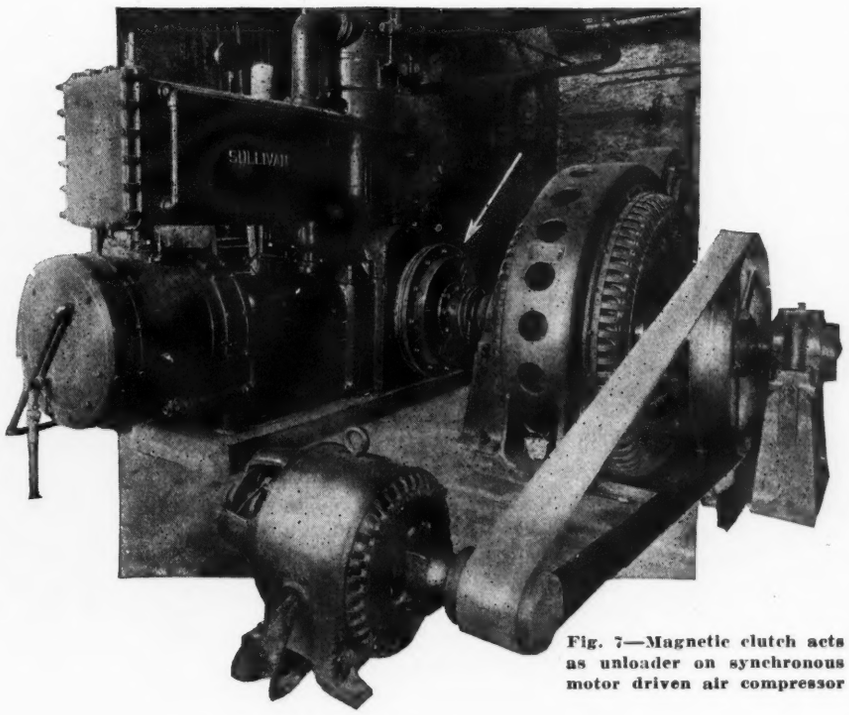


Fig. 7—Magnetic clutch acts as unloader on synchronous motor driven air compressor

The synchronous motor runs continuously to correct the power factor.

Because of frequent starting and stopping, clutch lining is subjected to a considerable amount of wear, and this is one of the most important considerations when selecting magnetic clutches for this service. As a general rule, for accumulator pumps magnetic clutches can be recommended where the frequency of starting is not greater than once every two minutes and the clutch speed is below 500 r.p.m. A magnetic clutch would need careful consideration where it would be required to operate twice a minute at 750 revolutions per minute.

When properly selected, the application of magnetic clutches to accumulator pumps works out successfully. In a steel fabricating plant there are two magnetic clutches that have been operating for more than 20 years. The user is satisfied that the maintenance on the clutches is more than offset by the saving in maintenance on the pumps.

An installation somewhat similar to that in Fig. 4 is shown in Fig. 7. Here the synchronous motor runs continuously and a clutch automatically connects and disconnects an air compressor. The clutch is actuated by a pressure-regulating switch which keeps the pressure between predetermined high and low values.

Another type of automatic control is where the clutch is mounted between a waterwheel and a generator. Should the load suddenly be removed from the generator through the opening of a circuit breaker, the speed tends to increase. To prevent damage to the generator a centrifugal overspeed switch automatically disconnects the waterwheel from the generator by disengaging the clutch before a dangerous speed is reached.

The unit in Fig. 5 provides power for the auxiliaries on one of United States Shipping Board Diesel-driven vessels. The Diesel engine is direct connected to a 340-kw. generator and also drives a compressor through a 32-in. magnetic clutch. The compressor supplies storage tanks with compressed air at 1,000-lb. pressure. Normally, the compressor is required to run for short periods only and when not needed is disconnected by the magnetic clutch. Here the clutch was selected almost entirely for mechanical reasons, namely, saving in space, simplicity, and ease of operation. The clutch is energized and de-energized by pressing a button, and the small amount of space it requires is evident by its relative size to the other requirement.

Fig. 6 shows two synchronous motors, each coupled through a magnetic clutch to a centrifugal pump. This installation is in a small central station. Ordinarily, the pumps are not in service, and the synchronous motors operate as condensers to improve the power factor of the system. During unusual demands for water the motors are coupled to the pumps. Thus, they serve a double purpose. These clutches run at 1,800 r.p.m. and each transmits 100 horsepower.

Gasoline engines in some industries and certain localities are required for stand-by or emergency service in the event of power failure. One economical arrangement has been worked out consisting of a gasoline engine and a motor-generator set. Normally, an alternating-current motor drives the direct-current generator to supply power for variable-speed drives. In event of power failure to the motor the engine can quickly be started by pressing a button. Starting the engine and energizing the magnetic clutch can also be done automatically. This arrangement is also applicable to mine fans, where a short shutdown is objectionable. It is also used in the cement industry, where it is essential that the rotating kilns be maintained in continuous operation.

There are many other applications for magnetic clutches in the paper, flour, rubber and other industries. Although those mentioned will give a general idea of their uses, they are not the limit of clutch applications, as new services for them are continually being found and developed.

Experience With

ZEOLITE and ACID

at Beacon St. Plant

By J. H. WALKER
Supt. of Central Heating
and L. F. COLLINS
Chemist
The Detroit Edison Company

THE ZEOLITE feed-water treating system installed in Beacon Street heating plant of the Detroit Edison Company has been in operation for about 3½ years, and sufficient experience has been accumulated to permit of conclusions as to its effectiveness and cost of operation.

A description of the installation and a discussion of reasons leading to its choice have been published,[1] but will be briefly reviewed. The purpose of the present article is to present the results of operating experience.

Developments in boiler design and firing methods have made possible great increases in rates of driving, with consequent reduction in investment costs. Most of these developments originated in electrical generating stations using distilled water or at least a high percentage of recirculated water. In a central heating plant the advantages of high steaming rates are at least equally great, but the large proportion of makeup water in such a plant (very little condensate being returned from the consumers' buildings) makes it difficult to avoid serious tube burnouts. Feed-water treatment thus becomes of primary importance. At Beacon Street, several methods of treatment were considered before zeolite was finally selected. It appeared to the engineers designing the plant that this method was most likely to produce complete freedom from scale, and experience has verified this conclusion.

Theoretically the zeolite method is open to the objection that it does not remove the dissolved solids, but merely converts them to more soluble salts, thus causing high concentrations in the boiler and requiring a large amount of blowoff. Another objection is that with a bicarbonate water such as that in Detroit the sodium bicarbonate produced by the treatment, unless removed by an after-dose of acid, would cause high alkalinity in the boiler. As a means of preventing scale formation, however, it appeared that the zeolite system would be certain of results, and this was the controlling factor in the choice. The large amount of blowoff is somewhat offset by the use of a heat exchanger, which salvages most of the heat in the blowoff; and alkalinity is controlled by the addition of acid to the water after treatment.

The primary purpose of the after-feed of sulphuric acid is to prevent cracking of the boiler metal, which has frequently been observed in boilers containing highly caustic water, and which, the authors believe, is somewhat erroneously termed embrittlement. Although no contributory evidence as to the validity of any of the theories regarding this phenomenon has been obtained in the company's plants, it was thought prudent to maintain in the boiler water the proportion of sodium sulphate that is considered sufficient to inhibit the action of sodium hydroxide as suggested by Parr and Straub[2] and recommended by the A.S.M.E. rules for the care of power boilers. A secondary result of the acid feed is that it reduces the carbon-dioxide content of the steam. With a water supply containing a considerable amount of calcium bicarbonate, there is ordinarily a considerable quantity of CO_2, which is removed by the deaërating feed-water heater.

Of the four plants that supply steam for heating in the central business district of Detroit, Beacon Street Station is the largest. It is designed to contain, eventually, twelve boilers, each having 41,500 sq.ft. of surface and capable of a steam output of 406,000 lb. per hour. The make-up water, amounting to about 80 per cent of total water to the boilers, is taken from the city water mains, the supply being drawn from the Detroit River.

The zeolite tanks are 10 ft. in diameter and 25-ft. long, set with their axes horizontal, as may be seen in Fig. 1, and constructed on the up-flow principle. The true relative merits of the up-flow and down-flow systems were found to be obscured by patent difficulties and commercial considerations; but there seems to be no fundamental objection to the up-flow system. The zeolite is of the green sand type, having a rated exchange value of 3,375 grains per cubic foot. The bed is 41 in. thick, and rate of flow at normal load is 4¼ gal. per minute per square foot of bed area. Total output per tank is 445,000 gal. between regenerations at the rate of 63,600 gal. per hour normal flow and with a maximum permissible flow of 75,000 gal. per hour. There are three tanks in the initial installation, but the completed plant will require six. Brine for regeneration is supplied to the zeolite tanks from a central overhead tank.

To insure a constant rate of flow regardless of fluctuations in city water pressure, a Venturi-type flow con-

[1] "Zeolite Water Treatment in a Large Central Heating Plant," by White, Walker, Partridge and Collins. *Proceedings*—American Water Works Association, 1927.

[2] Bulletins 94, 155 and 177 of the University of Illinois Engineering Experiment Station.

troller is installed. After leaving the zeolite tanks, the water is given a dose of acid and then flows into a concrete storage reservoir, indicated in Fig. 2. A float in the reservoir controls the flow through the zeolite tank by opening and closing the hydraulically operated gate valve at the inlet. Control is arranged so that the tank operates at its rated capacity or is shut off entirely. The up-flow method requires that the rate of flow be sufficient to maintain the zeolite bed in partial suspension.

Booster pumps lift the water to a head tank, from which it flows by gravity through a deaërating heater to the boiler-feed pumps. In the heater, water flows over a large number of trays which are swept by a countercurrent of steam that completely removes the dissolved gases.

One proportioning device for each zeolite tank feeds dilute acid to the water after it leaves the zeolite tank. Commercial concentrated sulphuric acid is used and is diluted to a 5 per cent solution. The dilute acid is pumped to the constant-level tanks of the proportioning devices. The amount of acid may be easily adjusted by changing the strength of the solution.

At Beacon Street the net blowdown amounts to about $4\frac{1}{2}$ per cent of the boiler feed. The continuous blowdown system makes possible extraction of the heat from the water and also gives more uniform steaming conditions than would intermittent blowing off of large quantities of water.

Fig. 3 shows the arrangement of the blowdown system. From the two mud drums of each boiler there is a 2-in. pipe provided with a needle valve for controlling flow. As water passes through the needle valve there is a considerable amount of steam flashed off. This mixture of steam and water is conducted through large pipes to a separating tank, from which the steam is vented into the exhaust system of the plant, in which a pressure of about 2 lb. is carried. Water flows from the separating tank through the heat exchanger, V-notch meter and thence to the sewer. A float-controlled valve regulates the flow so as to maintain a constant water level in the separating tank. The cold supply water on its way to the heater passes through the heat exchanger, absorbing the heat from the blowoff water.

It is contended that more attention should be given to the prevention of corrosion, the efficient use of salt and the control of water flow in the design of zeolite-and-acid systems

Blowdown is regulated by reference to a recording conductivity meter, the cell of which is located in the blowoff line ahead of the needle valve. The electrical conductivity of the salt solution in the boiler is a measure of the concentration, provided the kind of dissolved materials and their relative amounts with respect to each other remain the same. At present the concentration of dissolved solids is kept between 2,000 and 3,000 parts per million, and the corresponding conductivity is from 3,400 to 3,700 reciprocal megohms. This standard has been established by experience with this particular water composition and boiler design. If the concentration is allowed to become greater, a calorimeter in the steam outlet of the boiler will immediately show a definite increase in the moisture content of the steam.

The treating system as a whole, and the acid feed in particular, have been handled with considerable caution, but no serious troubles have been experienced. Daily operation is adequately carried on by the regular operating crew, control of the system being centered in one man working under the direction of a chemist. The principal thing watched is the amount of acid fed into the water. Frequent determinations are made of the pH

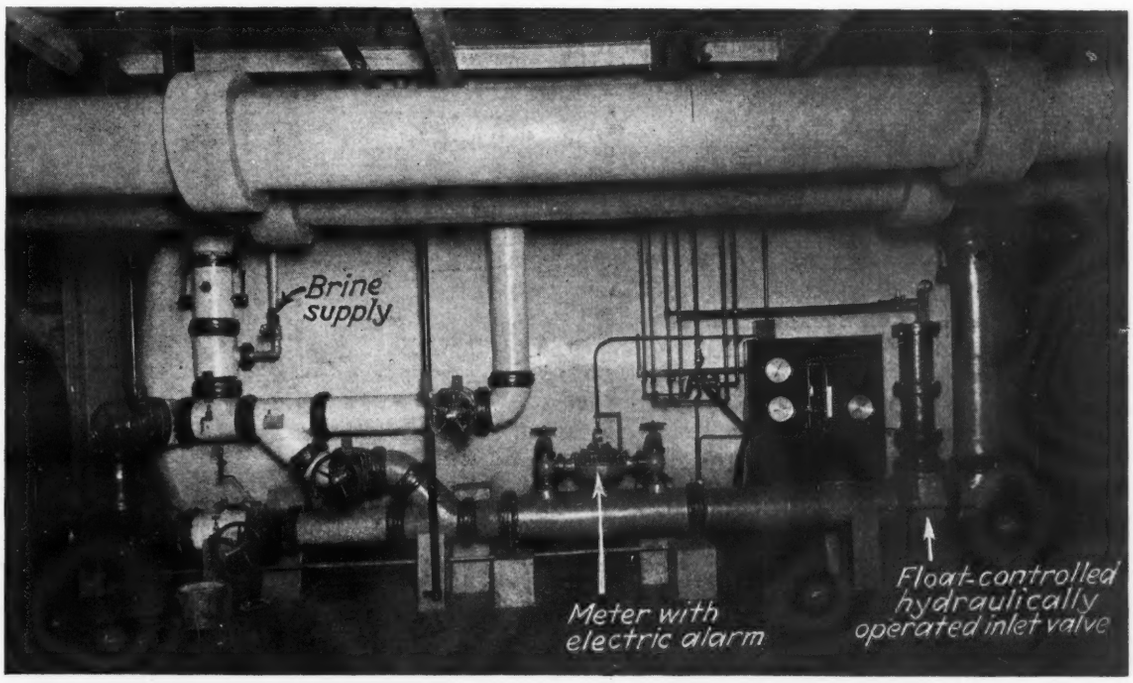


Fig. 1 — One of the three zeolite tanks operating on the up-flow principle

value of the water after the acid feed. The pH value is a measure of the hydrogen content of the water, and, consequently, of its acidity or alkalinity. The pH value of the cold water after acid treatment is approximately 6, but is much higher after deaëration. In the boiler the pH reading is about 11. Readings of pH are made by adding a few drops of an indicator to a measured

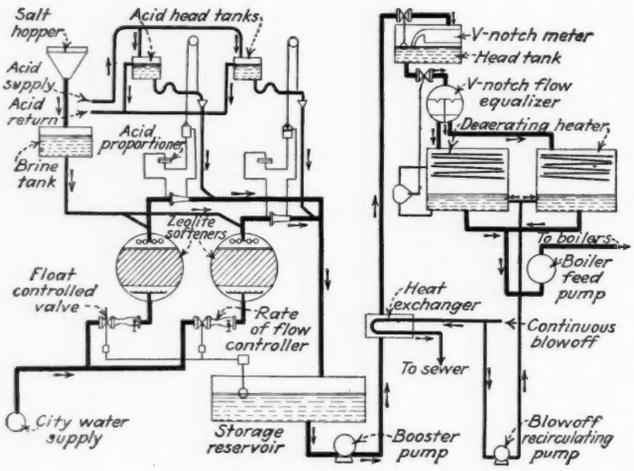


Fig. 2—Diagram of feed-water system

quantity of the water and comparing the color with a graduated set of standard color tubes.

A novel feature, developed after the plant went into operation, is the recirculation of a small percentage of the water from the boilers back to the feed-water heater. The first year's operation disclosed that the boiler feed water, after acid feed and deaëration, still contained a considerable amount of bicarbonate. Some corrosion was taking place in the boilers, apparently caused by the direct action between carbon dioxide and iron, since ferrous carbonate was found to have formed over the corroded areas.

Corrosion has been completely overcome by recirculating to the water space in the deaërating heater some of the alkaline boiler water taken from the blowoff system, as indicated in Fig. 2. This converts any bicarbonate into normal carbonate. The amount of water recirculated is varied according to the alkalinity of the blowoff water to maintain a pH value in the shell of the deaërator of about 9.8; it averages about 5 per cent of the boiler feed, this amount of recirculation being in addition to the 4.5 per cent of actual blowdown going to the sewer.

After some months of operation, it was considered advisable to augment the standard feed of 40 parts of sulphuric acid per million parts of water treated by a small amount of phosphoric acid. This acid is not essential to the operation of the system, but is added to precipitate the small amount of residual calcium ion in the water. It precipitates as tricalcium phosphate, which deposits in a thin film on the boiler surfaces and probably tends to prevent corrosion. At present 4.5 parts of phosphoric acid per million parts of water are fed, in addition to the sulphuric acid. Corrosion in the boilers is nil.

Troubles That Developed, and the Remedies

Three seasons of operation have brought to light a few troubles. The most serious of these is mild but active corrosion in the zeolite tanks and piping system. It is not due to the acid feed, for it begins immediately above the zeolite bed in the tanks, while the acid is introduced farther on in the piping system. It is probably due to carbon dioxide. It has been found possible to prevent it almost entirely by protective coatings, in places where such coatings may be applied, and by the use of cement-lined pipe in all additions to the plant where the pipes carry cold zeolite-treated water. Recirculation of blowoff water has stopped the action in that part of the piping system beyond its point of introduction.

There has been some shifting of the gravel bed which supports the zeolite mineral in each tank, owing perhaps to the failure of the flow controller to regulate accurately at all times. The softening capacity of the tanks decreased about 10 per cent because of this, but was brought back by replacing the bed properly. Future shifting of the bed is being guarded against by the introduction of vertical partition plates running both transversely and longitudinally within the tanks.

The salt brine for regenerating the zeolite is used at rather low efficiency, as only 30 per cent of the sodium in the brine is effective in regeneration, the remainder being wasted to the sewer. An attempt is being made to develop some method of regeneration less wasteful of salt.

The zeolite system consistently produces a water having an average hardness, expressed as $CaCO_3$, of slightly more than 3 parts per million. The up-flow method has been satisfactory, and there has been no serious loss of zeolite mineral. The acid feed neutralizes approximately half of the potential alkalinity of the zeolite-treated water, and produces a boiler water containing a sulphate concentration well above that prescribed to prevent caustic cracking. Suspended solids in the boiler water have averaged below 50 parts per million, this

TABLE I.—WATER ANALYSES AT VARIOUS POINTS IN THE CYCLE

	Raw Water	After Zeolite	After Acid Feed	After De-aerator	After Adding Recirculated Blow-Off[1]	Boiler Water	Steam
	Analytical Results						
	P. p. m.	P. p. m.	P. p. m.	P. p. m.	P. p. m.	P. p. m.	P. p. m.
pH value	7.6	8.1	6.2	8.6	9.8	11.3	6.0
Temperature:							
Deg. F.	40	40	40	215	217	367	363
Deg. C.	4.4	4.4	4.4	101.7	102.8	185.9	183.7
Pressure:							
Lb. per sq. in.	45	4.5	4.5	2	2	155[3]	140
Kg. per sq. cm.	3.17	0.317	0.317	0.141	0.141	10.91	9.86
Dissolved O_2[2]	20.4	20.4	20.4	0.067	0.067	0.0	0.057
Free CO_2	1.4	1.4	18.5	0.0	0.0	0.0	18.7
Dissolved solids	153.3	165.4	157.5	155.4	253.0	2087.0	1.4
Suspended solids	0.0	0.0	0.0	0.0	0.0	41.0	0.0
Total solids	153.3	165.4	157.5	155.4	253.0	2128.0	....
Hardness as $CaCO_3$	92.3	3.1	3.1	3.1	3.1	....	0.0
Ca	25.7	0.9	0.9	0.9	1.0	....	0.0
Mg	6.9	0.2	0.2	0.2	0.2	....	0.0
Na	4.2	45.4	45.4	45.4	85.4	715.0	....
SiO_2	1.0	3.2	3.2	3.2	....	....	....
P_2O_5	1.4	1.4	1.4	1.4	1.4	0.0	0.0
HCO_3	89.0	89.0	36.6	29.4	1.4	0.0	0.7
CO_3	0.0	0.0	0.0	2.9	30.0	104.0	0.0
OH	0.0	0.0	0.0	0.0	0.0	67.0	0.0
SO_4	18.7	18.7	58.7	58.7	108.0	1000.0	....
Cl	6.6	6.6	6.6	6.6	12.1	111.0	....
H_2PO_4	0.0	0.0	4.5	0.0	0.0	0.0	0.0
HPO_4	0.0	0.0	0.0	4.4	7.1	0.0	0.0
PO_4	0.0	0.0	0.0	0.0	0.0	15.0	0.0
	Probable Combinations						
$Ca(HCO_3)_2$	71.6	3.6	3.6	0.0	0.0	0.0	0.0
$Mg(HCO_3)_2$	42.0	1.2	1.2	0.0	0.0	0.0	0.0
$NaHCO_3$	0.0	117.5	45.0	40.4	1.9	0.0	0.0
$CaCO_3$	0.0	0.0	0.0	2.2	2.2	0.0	0.0
$MgCO_3$	0.0	0.0	0.0	0.7	0.7	0.0	0.0
Na_2CO_3	0.0	0.0	0.0	2.0	53.0	184.0	0.0
NaOH	0.0	0.0	0.0	0.0	0.0	157.0	0.0
$CaSO_4$	26.4	0.0	0.0	0.0	0.0	0.0	0.0
$MgSO_4$	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Na_2SO_4	0.0	27.6	87.1	87.1	160.0	1470.0	....
NaCl	10.9	10.9	10.9	10.9	20.0	183.0	....
NaH_2PO_4	0.0	0.0	5.5	0.0	0.0	0.0	0.0
Na_2HPO_4	0.0	0.0	0.0	6.5	10.5	0.0	0.0
Na_3PO_4	0.0	0.0	0.0	0.0	0.0	26.0	....
$Ca_3(PO_4)_2$	0.0	0.0	0.0	0.0	0.0	39.0[4]	0.0

[1] The amount of blowoff water added equals 5 per cent of the feed water.
[2] Parts per million times 0.698 equals cubic centimeters per liter at standard conditions.
[3] This is the average pressure at the header.
[4] Suspended matter is mostly $Ca_3(PO_4)_2$.

material being largely tricalcium phosphate produced by the addition of phosphoric acid to the acid feed.

The deaërating heaters have removed all free carbon dioxide and about 10 per cent of the half-bound carbon dioxide from the zeolite-softened and partially acidified water. They remove most of the dissolved oxygen, but

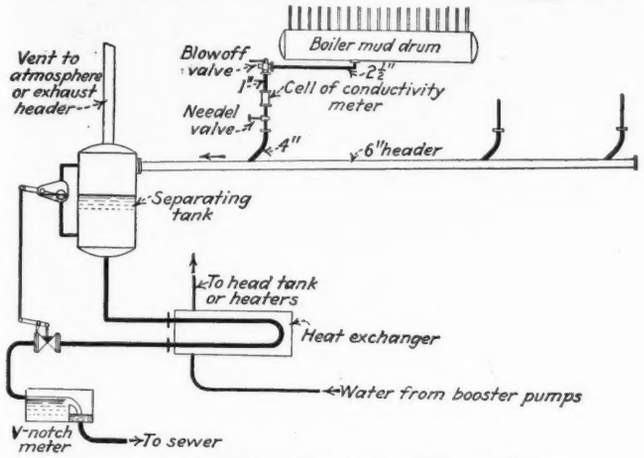


Fig. 3—Heat in blowoff water saved in continuous blowoff system

up to the present time have not consistently removed it to the expected degree during periods of full load.

In Table I are shown the water conditions at various points in the cycle. Passing the water through the zeolite softener increases the pH from 7.6 to 8.1. Introduction of acid causes it to drop again to 6.2 during its passage to the storage tanks. In the heaters the removal of carbon dioxide brings the pH up to 8.6, and the addition of recirculated water from the blowdown steps it up still further to 9.8. Further removal of carbon dioxide in the boiler gives a value for the boiler water of 11.3, but this carbon dioxide passing out with the steam to the mains gives the steam condensate a pH of 6.

There has never been any appreciable amount of scale in the boilers. No tube burnouts have been experienced during three seasons of operation at steaming rates up to 300 per cent maintained for periods of several hours at a time. On the whole, the zeolite system and the acid feed have been satisfactory from the standpoint of boiler-plant operation.

In considering the expense of the treatment it should be recognized that there are certain costs that are constant, regardless of the amount of water treated, and other costs that vary almost in proportion to the amount treated. The attendance labor, for example, is in the former class, while the salt and acid costs are in the latter.

TABLE II.—ANNUAL OPERATING COST OF FEED-WATER TREATMENT SYSTEM

(Data taken from Jan. 1, 1929, to and including Dec. 31, 1929.)

A—Costs which are fixed regardless of amount of water treated:		
Labor[1]	$2,184.00	
Miscellaneous[2]	100.00	
Total fixed costs		$2,284.00
B—Costs that vary with amount of water treated:		
Salt—299.55 tons @ $7 per ton	$2,096.58	
Acid—sulphuric—33.86 tons @ $40 per ton	1,354.40	
Acid—phosphoric—4.17 tons @ $180 per ton	766.78	
Wash water—10,735 M. gal. @ $0.053 per M. gal.	568.96	
Total variable costs		$4,786.99
Total costs		$7,070.99
Amount of water treated, gal.		178,080,000
Cost, item A, per M. gal.		$0.0129
Cost, item B, per M. gal.		0.0268
Total cost per m. gal.		$0.0397

[1] Does not include time of supervising chemist nor of plant operators who devote only a small part of their time to operation of the treating system.
[2] Includes laboratory supplies and replacements on acid pumps.

This point is particularly important in the present case because of the wide seasonal variation in load.

Table II shows the operating costs divided into these two classes. The total cost of one full year of operation, during which 178,080,000 gal. of water were treated, was $7,070.99, or a cost of 3.97 cents per 1,000 gal. For a plant in continuous operation this might be lowered considerably.

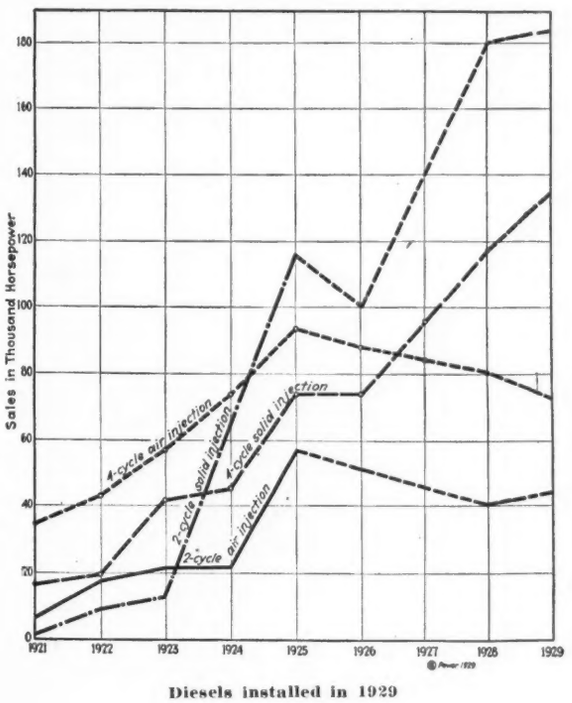
The zeolite system supplemented by acid treatment appears to be entirely feasible for a large boiler plant using Detroit water. It probably would not be satisfactory at Beacon Street without intelligent chemical supervision, but such supervision would have been provided with any other method of treatment because of the extreme importance of the water conditions to the operation of the plant.

More attention should be given to the design of zeolite systems as regards control of the flow, prevention of shifting of the bed, the efficient use of salt and the prevention of corrosion.

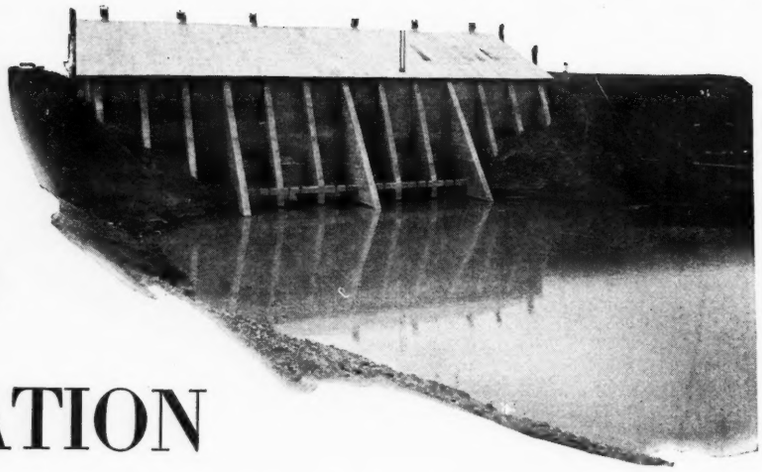
Diesel Engines Installed in 1929

CONTINUING the custom *Power* has followed for several years, the Diesel engines installed in 1929 have been tabulated and are shown in the illustration. This chart covers the engines installed since 1921.

As will be seen, the two-stroke-cycle solid-injection Diesel has the greatest sale, and 1929 figures exceeded 1928 by a small margin. The greatest increase in engines installed during the year is the four-stroke-cycle solid-injection Diesel, which shows the same rate of increase that has existed since 1926. The total of the four classes installed during 1929 is 409,000 hp. Probably 10,000 to 15,000 hp. escaped tabulation, making the total about 420,000 horsepower.



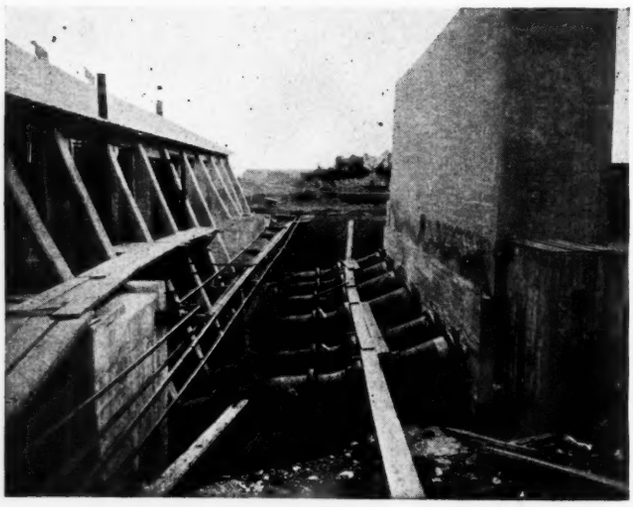
Diesels installed in 1929



View of the power house and the intake bay

OIL POWER FOR IRRIGATION *Along the Rio Grande*

By ORVILLE ADAMS



The Venturi tubes in the discharge lines

This discharge tube extends 1,154 ft. from the power plant

INSPECTION of an aviation map shows the Rio Grande River Valley in Texas to be interlaced with a network of irrigation ditches, without which that fertile spot would be as sterile as the staked plains. Water for irrigation is pumped from the Rio Grande, and while formerly steam power was used extensively, of late years Diesel pumping plants have been given supersedence.

While early Diesel plants were installed without the necessary equipment, the newer plants are adequate in every respect and capable of reliable and continuous operation at a cost in keeping with the claims made for this type of prime mover.

One of the outstanding plants is that of the Hidalgo Water Improvement District No. 4, at Edinburg, Texas, now in its fourth year of operation. This plant has a record of economy for satisfactory operation, upkeep and maintenance that could not have been possible without proper engineering and sufficient auxiliary equipment for protecting the engine, cleaning the fuel, lubrication and control of the cooling water.

The plant contains six 360-hp. Fairbanks-Morse Diesel engines, each equipped with slow-down devices. Each engine is direct connected to a 30-in. centrifugal pump which handles water at a rate of 23,300 gal. per minute against a total maximum head of 40 ft., with a pump efficiency of 84½ per cent. At high water the head does not exceed 20 ft., and at such times the engines are slowed down by the speed regulator.

A 48-in. discharge from each pump leads to a 48-32 in. Venturi meter, with a recording device to show the rate of discharge in second-feet and the total discharge.

The exhaust of the engines passes through large chimneys cast in the end walls of the building, while other chimneys are cast in the end walls through which fresh air is drawn. The air conduits pass down into the concrete floor for three feet and there connect with two-foot terra cotta pipes under each engine communicating with the crankcase. Shutters located directly in

front of each engine control air entrance into the chimney, so that air may be drawn from either the outside or the inside of the engine room. On the walls in front of each engine are mounted exhaust pyrometers for maintaining close supervision of each engine's exhaust temperature, cylinder balance and exhaust-heat conditions.

Lubricating oil storage tanks are in an adjacent warehouse, as is a Sharples centrifuge. From the storage tanks the oil is piped to the power house, where it enters small tanks located at each end of the buildings and near the engines.

When the oil has passed through the engine, it is collected by the lubricating oil pumps and passed into a bag filter, where all large particles are removed. From the bag filter it is allowed to drain into the dirty-oil storage tanks under the floor. After settlement there it is pumped to the warehouse by a rotary pump. When dirty oil has accumulated in quantities of 300 or 400 gal. a wood fire is built under the drum and the temperature raised to 180 or 200 deg. The warm oil is then passed through a centrifuge and back to the clean-oil storage tanks for re-use.

A kerosene-heated copper coil between the dirty-oil storage tank and a Nugent bag filter provide for emergencies in case of failure of the centrifuge. Operating records show that the lubricating oil consumption with all six engines in operation is 1.02 gal. per hour.

A closed system is employed to supply a safe cooling water. Water flows by gravity to the engines from a 10,000-gal. cypress tank. Leaving the engine, the water enters a hot-water sump, from which it is picked up by the circulating pumps and forced through a series of pipe coils, cooled by raw water flowing over the outside surface.

Make-up is first passed through a zeolite water softener. This procedure has eliminated scale trouble, and all the original heads and combustion chambers that come with the engines are still in use. Water-circulating pumps for the cooling system are run direct from the main machines by a silent-chain drive.

A 20-hp. auxiliary oil engine, belt-connected to a 12.5-kw. direct-current generator, supplies electric lights for the plant and operators' quarters.

The generator is placed so that it can be belt-connected to a main engine, and is operated in this manner when either of the main engines is running. Other auxiliary equipment comprises a Connersville blower direct connected to a 10-hp. motor for priming the pumps, and a stand-by priming unit comprises a 10-hp. gasoline engine direct connected to a blower.

To supply starting air for the engine there is a two-stage Ingersoll-Rand air compressor direct connected to a 12.5-hp. motor, with one 3-hp. gasoline engine direct connected to a small compressor as stand-by. The plant is also equipped with a 5-ton Brownhoist crane for handling heavy parts during inspection and repair of the engines.

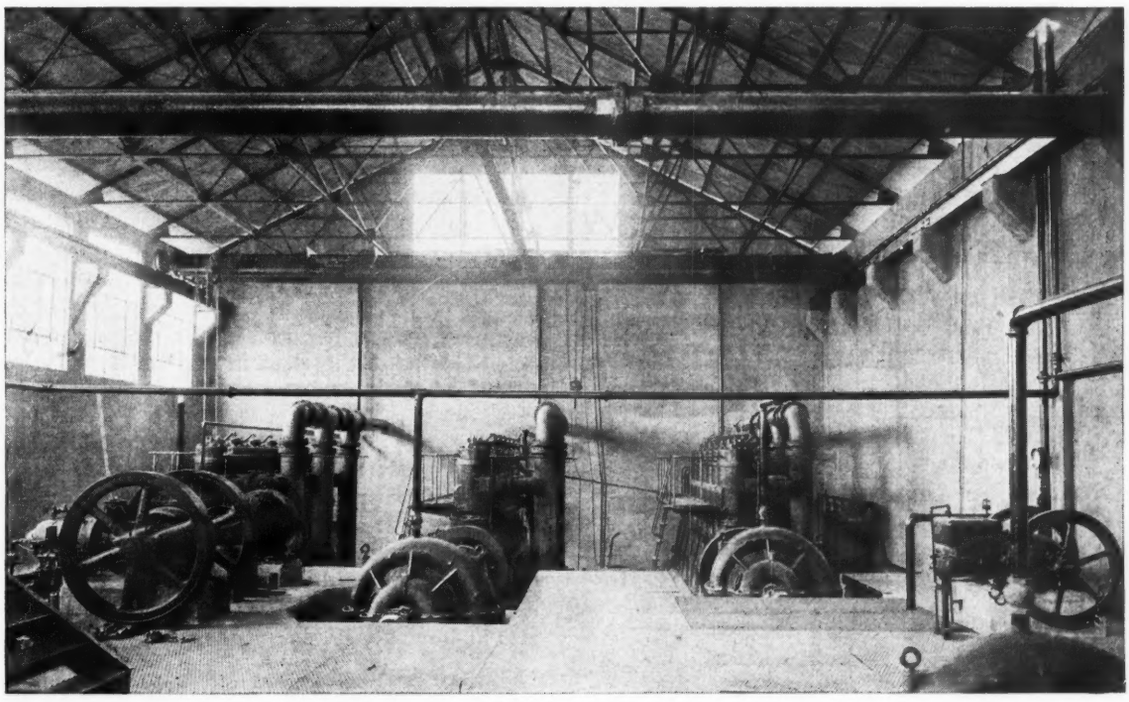
The fuel and lubricating oil consumed during a six-months' run in 1929 are shown in the table:

OPERATION OF HIDALGO PLANT, (Jan. to July, 1929)

Months	Eng. Hr. Run	Lub. Oil Used	Fuel Oil Used	Acre-Ft. Pumped	Cost of Repairs
Jan.	864.5	146.97	19,057	4,438.65	
Feb.	2,380.0	404.62	50,508	11,118.45	$5.55
Mar.	1,311.0	222.89	27,791	6,358.79	38.85
April	484.0	82.30	10,192	2,379.03	88.50
May	906.5	154.22	19,515	4,307.27	
June	412.5	70.10	8,907	2,046.10	
July	796.5	138.40	16,934	5,725.62	
	7,155.0	1,219.50	152,904	36,373.91	$132.80

Repair items cover new piston rings, replaced in the third year. Although the original rings lasted three years without much wear, they were replaced as a safety precaution. The other operating items are: Miscellaneous supplies, gaskets and rags, $72; fuel oil, 152,904 gal., $7,262.94; lubricating oil, 1,219.50 gal., $510.93; and labor of engineers and oilers, $5,412.50. Cost of pumping, not including fixed charges, was 0.389c. per acre-foot. The average static head over this period was 35.8 feet.

The three engines shown make up one-half of the plant



Ammonia Liquid Level Indicators

By R. S. Wheaton

DETERMINING the liquid level in an ammonia receiver is a relatively simple matter. An ordinary gage glass as used on a boiler will indicate the level of the ammonia, because pressure in the receiver is sufficiently high to keep the ammonia in a liquid state, free from boiling, as occurs in the evaporative, or low-pressure, side of a system. It is the violent ebullition and boiling of the liquid ammonia in the low-pressure side that makes it difficult to determine the liquid level, which, in a shell-and-tube type of evaporator operating without and accumulator and float control, must be carefully watched to prevent "slopovers" or liquid "slugs" coming back to the compressor and perhaps wrecking it.

If the ordinary gage glass arrangement is used on a shell-and-tube evaporator the ammonia will evaporate and there will be no level to observe. After a short time the glass will become covered with frost and the ammonia cannot be seen at all.

ONE METHOD of overcoming this condition is shown in Fig. 1. Several small pipes, welded shut on the outside ends and opening into the interior of the cooler on the other ends are welded to the shell of the cooler, in a slanting position as shown. When the ammonia level gets high enough to flood the lower tube the end of that tube will frost up heavily, and if the ammonia level continues to rise the other tubes will flood and frost on the ends projecting through the insulation. If the ammonia level falls below the opening of one of these pipes the ammonia in the pipe will drain out and the frost on the outside end will disappear, because the pipe is then a dead gas pocket and the end is kept cold by conduction only.

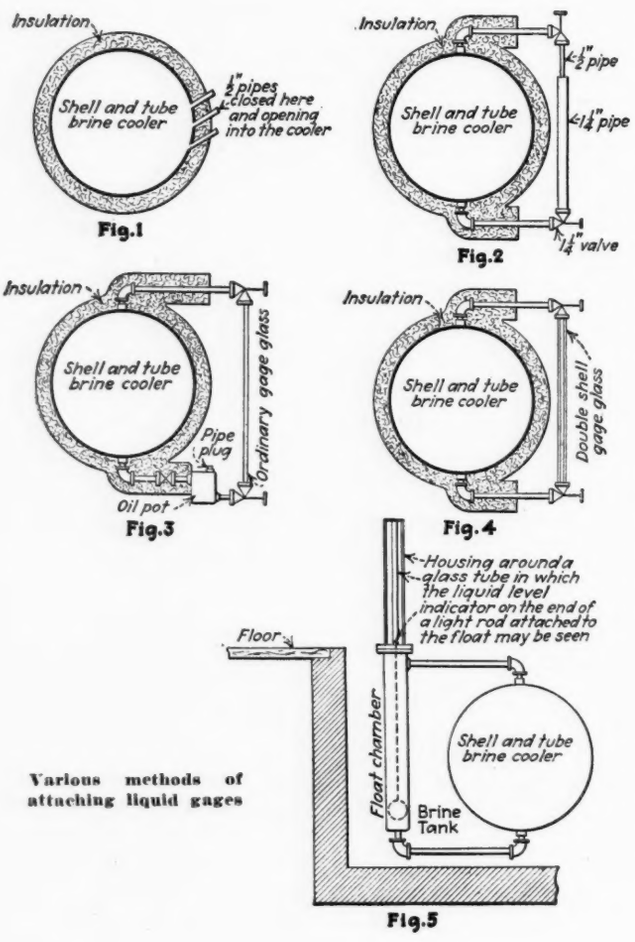
A more elaborate form is shown in Fig. 2. In operation the lower $1\frac{1}{4}$-in. valve is opened a turn or so and the top $\frac{1}{2}$-in. valve is just cracked a little. The ammonia level will ascend in the $1\frac{1}{4}$-in. pipe to the level of the ammonia in the cooler and will cause a heavy frost on the $1\frac{1}{4}$-in. pipe up to the ammonia level and a lighter frost above it. If the top valve is closed the frost will leave the pipe, because there will be no evaporation or cooling taking place in the pipe.

A WAY to use a gage glass in connection with an oil container in the level reading circuit is shown in Fig. 3. Ice machine oil with a sufficiently low pour point for the work is run into the oil pot through a pipe plug opening. The opening is closed and the valves opened. The weight of the ammonia forces oil up the gage glass, giving a fairly accurate reading. It is to be remembered that oil is heavier than ammonia and therefore the level of the oil in the gage glass forming one-half of the theoretical U-tube will be about $\frac{1}{3}$ lower than the level of the ammonia in the cooler, which forms the other half of the U-tube.

A rather recent development in which a special double-shell gage glass built along the line of a thermos bottle is used appears in Fig. 4. The construction prevents radiation of heat through the walls of the glass, with the result that the level of the liquid ammonia can be determined quite readily.

WHEN a cooler is installed in a brine tank whose walls are not accessible for the mounting of level indicators, the apparatus shown in Fig. 5 can be used. It consists of a float chamber made of 6-in. pipe connected as shown to the cooler. To the top of the float chamber is secured a gas-tight gage glass. The float carries a light steel drill rod having a metal indicator free to slide up and down inside of the glass, so that when ammonia is introduced, the level in the cooler is established in the float chamber, and the indicator shows it.

The top valve on gage glasses carrying ammonia should be opened first, slowly, so that if the glass should burst solid liquid will not be liberated. Gage glasses have been known to burst when being put into service. As there is usually liquid back of the lower valve, it should not be opened until after the top valve. If the gage glass assembly carries the pressure, the lower valve may be opened to place the glass in service.



Various methods of attaching liquid gages

✦

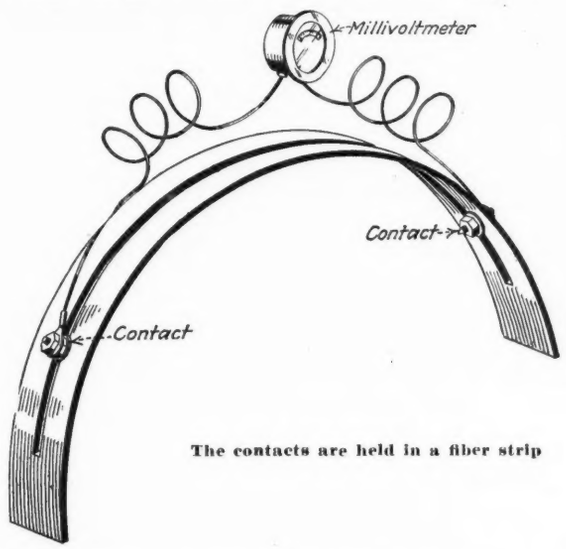
Gross earnings of public-utility enterprises in January, exclusive of telephone and telegraph companies, as reported to the Department of Commerce by 95 companies or systems operating gas, electric light, heat, power, traction and water services were $211,000,000, as compared with $211,500,000 in December, and $203,000,000 in January, 1929.

. . . RIGHT OUT OF THE PLANT . . .

Testing Wave-Wound Armatures

WHEN testing armature coils by means of a millivoltmeter there is sometimes difficulty in locating the commutator segments to which a particular coil is attached. This does not occur with lap-wound armatures, as the coils are attached to adjacent segments; but in wave-wound armatures the coils are connected to segments one pair of poles apart on the commutator.

A device useful for testing wave-wound armatures is made from a strip of sheet fiber about two inches wide and long enough to reach more than half way around



The contacts are held in a fiber strip

the commutator. A slot is cut in this as shown. Two contact points are held in the slots by nuts and are connected to a millivoltmeter.

When testing, the correct segments are first located and the two contacts adjusted to bear on them. As the pitch of the coils will not vary, the contacts when once fixed will be correct for the other segments in the commutator. The armature can then be tested without further trouble in locating the segments, as those on which the contacts bear will always be connected to the same coil. The strip can easily be bent to the radius of the commutator.

W. E. WARNER.

Brighton, England.

Using Heavy Fuel Oil in Solid-Injection Diesel Engines

THE QUESTION whether solid- or air-injection Diesel engines will work out best in burning heavy boiler oil was discussed in the Feb. 4 number of *Power* and further dealt with by T. C. Hulton of the Compania Minera Chambas in the March 11 number. May I add the following contribution based on by own observations, which have convinced me that solid-injection engines have the advantage?

I do not know whether the De LaVergne system of solid fuel injection, used in the engines mentioned by Mr. Hulton, is responsible for the excellent results, but I can say that with this system there is no real difficulty in burning boiler fuels of 12 to 14 deg. Baumé.

I have just returned from South America, where I erected an eight-cylinder 17x24-in., four-stroke-cycle, solid-injection, 850-hp., 231-r.p.m. De LaVergne Diesel engine at the Frigorifico Artigas plant, owned by Armour & Company and located near Montevideo. This engine drives a 570-kw. 50-cycle alternator that furnishes electric power for the motors and lights of the whole plant. The engine is practically a duplicate of two engines installed by me a year ago in a similar plant owned by the same concern in La Plata, Argentina.

As light fuel in these locations costs about three times as much as heavy fuel, three engines in both plants are operated, and have been operated since their installation, on Mexican or Venezuelan fuel of 12 deg. to 14 deg. Baumé gravity, the same kind of fuel burned under boilers.

The heavy fuel is received in railroad tank cars, which are heated by exhaust steam coils previous to unloading. The tank cars are unloaded by means of steam pumps into main storage tanks located above ground. These tanks are equipped with steam coils that maintain the fuel at a temperature of about 150 deg. F. From the main storage tanks the fuel used in the Diesels runs by gravity through a screen filter with heating jacket and from there through a centrifuge to a small storage tank located in the basement of the power house. From the small storage tank, which is not heated, the fuel is pumped by a motor-driven gear pump to a 100-gal. service tank located on the wall of the power house above the engine. The service tank is heated by an exhaust-steam coil. From the service tank fuel flows by gravity through a 1½-in. pipe surrounded by a 3-in. exhaust-steam-jacketed pipe to the engine fuel pumps. It reaches them at a temperature of 200 deg. F. The fuel lines from the pumps to the cylinders are insulated with asbestos rope to prevent cooling before reaching the spray valves.

The engines are started on light fuel, which is stored in a special tank near the heavy-fuel service tank, a separate pipe leading from this service tank directly to the engine fuel pumps. The light fuel is heated by an exhaust-steam jacket to preheat the fuel pumps and piping to the spray valve. After about two minutes the light

fuel is turned off and the heavy fuel turned on. Before shutting down, light fuel is again turned on for a few minutes, cleaning the fuel pumps, fuel lines and spray valves of heavy fuel.

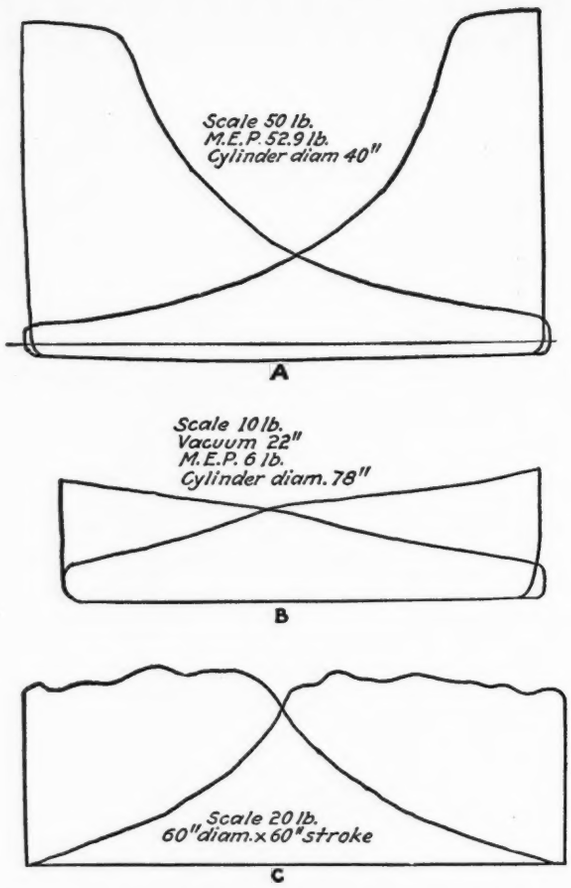
The two engines at La Plata have been operated for over a year in this manner without difficulty, although the load changes continually from no load to overload. The exhaust is invisible from about one-quarter on up to full load, but has a bluish white haze at extremely light loads. The maximum overload capacity is 30 per cent with the heavy fuel and 20 per cent with the light fuel. No inconvenient carbon formation occurs. The exhaust valves are cleaned every three months as a precaution.

Centrifuging the fuel is very necessary and has been instrumental in improving operation to the excellent results stated above.

If exhaust steam is not available, then water heated in a waste-heat boiler or in the jackets of the exhaust manifold could be used, the disadvantage being that the engine would have to run some time on light fuel before the heavy fuel would become sufficiently hot. This disadvantage, however, could be overcome by installing an electric heater in series with the waste-heat boiler or exhaust manifold jackets.

In conclusion, I might mention that an air-injection engine installed in a near-by plant and operated on the same fuel has to have the exhaust valves cleaned every six days, and in addition has difficulties with spray-valve needles.

A. H. WIRZ,
Philadelphia, Pa. I. P. Morris & De LaVergne, Inc.

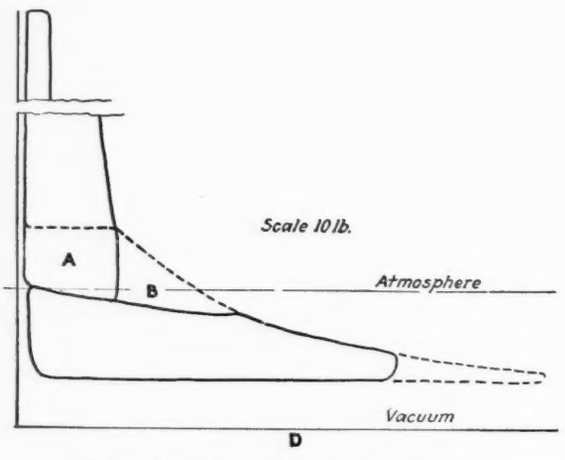


Indicator diagrams from high- and low-pressure steam cylinders and air cylinder

Increasing Load on Low-Pressure Cylinder of Compound Engine

BELIEVING it better to take an actual case for discussion in the "Right Out of the Plant" section rather than "Consider an engine with constant unchangeable load," as suggested by Raymond Bennett in the Jan. 14 number, the following is submitted, from many examples that have come in my experience. The details of the unit from which the diagrams were obtained are as follows:

Steel plant, Bessemer blowing engine, cross-compound steam cylinders; tandem air cylinders; single wristplate corliss on high pressure; double wristplate corliss on low pressure; cut-off on both cylinders controlled and adjustable by hand, the governor functioning as a speed limit only; high-pressure steam cylinder 40 in. in diameter; low-pressure steam cylinder 78 in. in diameter; air cylinders 60 in. in diameter; all cylinders have a common stroke of 60 inches.



Combined high- and low-pressure diagrams

Rough measurement of the diagrams shows the high-pressure to be doing more than twice the work of the low-pressure. The combined diagrams, as at *D*, show that when the low-pressure cut-off is shortened to about the volume of the high-pressure cylinder, the area *A* on diagram *D* will be transferred to the low-pressure diagram, and area *B* which represents a loss, largely from drop in pressure at high-pressure release, will be eliminated, and the load will be about evenly divided between the high- and low-pressure cylinders. D. P. TOLTON.

Lakewood, Ohio.

[The reason for the difference in lengths of the diagrams shown is undoubtedly due to the adjustment of the reducing motion.—Editor.]

Holes Through Concrete Floors

IN THE March 11 number of *Power* was described a method of putting holes through concrete floors. The method of drilling shown, using chilled steel shot, is standard practice throughout the world for the taking of samples for geological purposes. By this means cores may be removed from the earth from a depth of several thousand feet, and by placing these cores end to end the structure of the earth from the surface down becomes an open book. It is thus used for determining locations

of mineral deposit, oil, sand, etc. I venture to say that there is hardly an outlying district where this kind of work is going on where these drills have not been at work at some time or other.

Cores taken from concrete pavements by the machine illustrated in the March 11 number are taken to the state highway laboratories and there subjected to tests to determine whether or not the highway contractors have lived up to their contracts. Such cores give a perfect cross-section of the pavement for its full depth.

This is one of our standard product machines adapted to a special use.

S. B. REDFIELD,
Assistant Chief Engineer,
Ingersoll-Rand Company.

New York City.

Testing and Keeping a Record of Fuses

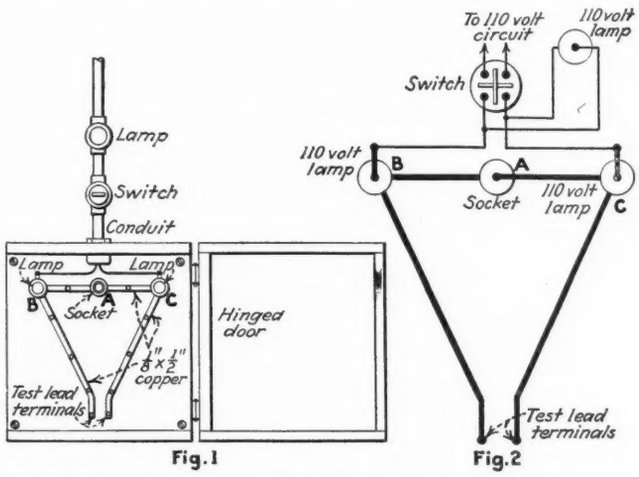
BY MEANS OF the tester illustrated fuses of the cartridge and plug types, as well as standard screw-base lamps can be quickly tested. The tester should be installed in a central location in departments where fuses must be frequently checked.

Two $\frac{1}{8}$x$\frac{1}{2}$-in. copper bars are screwed to a small slate or ebony asbestos panel, as in Fig. 1, and arranged so as to be spanned by the longest and shortest cartridge fuses in use. Maximum and minimum distances of 10 and 2 in. between bars are generally suitable. At the bottom of the bars, terminals are provided for attaching leads when necessary for testing other apparatus.

Lamp and plug fuses are inserted in socket *A*. The threads of the brass shell of this socket should be flattened so that the device to be tested need be but pushed into the socket. *B* and C are small 110-volt lamps connected in series with the testing bars. These lamps glow at half voltage when a fuse tests good.

The tester is fully inclosed by a hinged door or cover made of ebony asbestos. A double-pole snap switch is connected as shown in Fig. 2. Above it a pilot lamp indicates when the tester is energized. The latter should be connected to a circuit that is continuously energized. Wiring is done in conduit, and the tester should be securely bolted to the wall.

A supply of spare fuses and reloading links is usually kept near a fuse tester of this type. One method of keeping links and assembled fuses in good order is to provide pigeon-hole compartments in a cabinet. Fuses and links of each rating should be kept separately, and the contents of each compartment should appear on a suitable tag or nameplate. The ampere rating of each fuse should be indicated, small numbered stickers being suitable.



Figs. 1 and 2—Test panel for fuses and lamps

COMPLETE FUSES						RENEWABLE LINKS					
Amp.	Volts	Quantity Max.	Quantity Min.	Form	Desig-nation	Amp.	Volts	Quantity Max.	Quantity Min.	Form	Desig-nation
400	600	6	3	Cart.	CR400-6	400	600	18	12	A	L400-6
20	250	16	8	Plug	P20-25	30	600	30	10	A	L30-6

Fig. 3—Form for listing spare fuses and links

APPARATUS FUSED		Pro-tection for	Con-nected to Cir.	Num-ber of Fuses Req.	FUSE TO USE				Remarks
Name	No.				Amp.	Volts	Form	Desig-nation	
Pr. Fdr. Sw.	401	Cir.401	P401	3	400	600	Cart.	CR400-6	None
Motor Sw.	415	Motor 5	P401	3	100	600	Cart.	CR100-6	None

Fig. 4—Form for listing fuses in service

To avoid mistakes when replacing fuses the ampere capacity should be marked near each fuse, and a list of all fuses used in that particular department should be posted near the fuse cabinet. One method of listing fuses is shown in Figs. 3 and 4. Required fuse capacities are sometimes indicated on stamped plates attached to the doors of safety switches and fuse boxes.

Pittsburg, Calif. ROBERT BALL.

How the Wear on the Piston Was Reduced

REFERRING to an article in the Feb. 18 issue by G. W. Clarke on "How the Wear on the Piston Was Reduced," increased wear on the piston which occurred after the superheat had been increased 50 deg. was the natural thing to expect under the conditions as stated by Mr. Clarke. In the first place, the piston was built for certain conditions and performed satisfactorily. But when conditions were changed no alterations were made on the piston. It is also quite probable that the lubrication failed because a proper grade of cylinder oil was not used. The flash point of the oil was not high enough to withstand the increased temperature.

In purchasing a new bull-ring from the manufacturer he was not appraised of the true operating conditions, and of course the natural thing for him to do was to check his records for that engine, then supply the same as was originally furnished with it. Had he been appraised of true conditions he would have advised the installation of a bull-ring that contained a ring or two of anti-friction metal, placed in a dove-tailed groove around the piston and peaned in place, thus making a better mechanical job with better wearing qualities than it is possible to obtain by the insertion of the harder metal riveted in place.

In any event, proper lubrication is the important thing to be looked after and maintained to eliminate excessive wear. M. G. MCCULLOUGH.

San Angelo, Texas.

From Among Readers' Problems

Conducted by
L. H. MORRISON

DIAMETER OF BOILER STACK—*How can the diameter of the stack required by a hand-fired boiler of 3,000 sq.ft. heating surface be found.*

G.C.R.

According to John E. Bell, the stack diameter can be found by the formula

$$\text{Sq.ft. of boiler surface} = 10\left(\frac{D}{4.68}\right)^{\frac{3}{2}}$$

where D is the stack diameter in inches. This diameter will permit the boiler to operate up to 150 per cent rating, which is about the maximum for hand-fired boilers, and enables the burning of 0.5 lb. of coal per square foot of boiler heating surface.

William Kent suggested the formula:

$$E = A - 0.6\sqrt{A}$$

$$H = \left(\frac{0.03\,S}{E}\right)^2$$

where A = Actual stack cross-section, sq.ft.
E = Effective stack cross-section, sq.ft.
H = Stack height, ft.
S = Boiler-heating surface, sq.ft.

Such rules must be used with caution, and, before designing the stack, calculations should be made to see if, with the assumed combination rules, the height and diameter are such that the draft will be sufficient to supply the air.

—❖—

EFFECT OF ALTITUDE ON TURBINE EFFICIENCY—*How much difference is there in the efficiency of a 1,875-kva. condensing turbine-generator operating at 3,500 ft. above sea level, and one of the same type operating at sea level, assuming the vacuum in both cases to be 1½ in. below barometric pressure? The boiler pressure is 200 lb. gage.* H.T.H.

The efficiency of a turbine depends upon the ratio between the initial and condenser pressures. If the vacuum is 1½ in. below the observed barometric pressure, the actual absolute pressure in the condenser is the same in both instances.

At a normal atmospheric temperature of 60 deg., the sea-level absolute pressure is 14.7 lb. per square inch, making the absolute pressure of 200-lb.-gage steam 214.7 lb. At 3,500 ft., taking the 40-deg. latitude as an example, the normal temperature of the air at 3,500 ft. should be 46 deg. F.; the absolute pressure would be 0.93 of that at sea level, or $0.93 \times 14.7 = 13.67$ lb. The 200-lb.-gage boiler at 3,500 ft. would have an absolute pressure of 213.67 lb., so the pressure ratio would be greater.

The decrease in the turbine thermal efficiency, while an actuality, would be too small for consideration.

—❖—

SODIUM DICHROMATE AS A CORROSION RETARDER—*Will sodium dichromate prevent corrosion in a brine tank?*

C.M.T.

The influence of sodium chromate on the corrosion of iron and steel by calcium brine was investigated by the Corrosion Committee of the A.S.R.E. It was found that the addition of sodium dichromate to the brine gave an increased protection to iron and steel when the dichromate was neutralized, that is, converted to sodium chromate by the addition of caustic soda. In other words, sodium chromate is a more efficient retarder for iron and steel than the dichromate per unit of chromium in the brine. Because of its common use in the arts, however, the dichromate is cheaper and more readily available than the chromate. It is, therefore, advisable to purchase the dichromate and neutralize it in the brine tank.

If the 76 per cent commercial flake caustic soda is used for neutralization, 35 lb. should be added for each 100 lb. of dichromate. Slightly less than this amount of caustic is necessary if the brine is alkaline before treatment.

The most effective concentration of dichromate to use is 200 lb. per 1,000 cu.ft. of brine. It is not advisable to use this salt in open systems, however, because the workmen handling the brine are likely to be affected by "chrome itch."

Tests on galvanized material, brass, bronze, and Admiralty metal showed that about 90 per cent protection to these metals could be obtained by the use of dichromate neutralized with caustic soda.

PREVIOUS QUESTION

Discussed by Readers

THE QUESTION

WE are installing a gas-fired hot-water heater, taking the water direct through the meter from the city mains, and the city pressure is used to force the water through the house lines. The inspector insists on a safety valve, but I cannot see how over-pressure is possible. Is a safety valve necessary? P.V.R.

SAFETY VALVES, or so-called relief valves, are essential in all hot-water heaters and tanks. This applies to fired vessels, especially where the water is heated by the combustion of fuel in contact with the coils, sheets, or cast-iron sections of a heater. Where the water is heated by the condensation of steam in submerged coils within the tank and the steam pressure does not exceed the safe working pressure of the tank, the safety valve on the boiler or on the low-pressure side of the regulating valve is sufficient protection.

This applies to tanks that operate at no higher temperatures than 185 deg. F., as the pressure due to expansion must be taken into consideration.

It is common practice to provide the city feed pipe with both a stop valve and check valve, the purpose of the latter being to prevent the water backing into the street in event of a failure of or interruption to the service pressure.

The water leaving a fired vessel would cause considerable damage, probably an explosion.

I strongly recommend a check valve in the feed pipe, and a relief valve on the storage tank, with no stop valves between it and the heater.

The relief valve is often considered as needing no attention; but if allowed to corrode or rust it will be as good as none at all. It should be taken apart and cleaned at least three times a year.

H. W. HULSMANN,
Chicago, Ill. *Boiler Inspector.*

SOME TIME AGO a gas-fired water heater that was supplied from the city water mains through a meter and a service, which also supplied several other small houses, was left burning for several hours without any use being made of the hot water. The result was a supply of hot water at the other houses, which flowed from the cold-water faucets, and finally the coils in the heater melted.

Undoubtedly the steam pressure generated in the system was not higher than the city water pressure and a safety valve would have been of no value, unless it was of a type that would permit the passage of a vapor and not a liquid. If such a valve had been installed at the top of the tank the steam would have escaped and a flow of cold water would have been assured for the heater, which would have prevented its injury.

It seems to me that a safety valve, or, rather, a vapor-bleeding valve, would be a practical application, but its setting would have to be such that it would open slightly below the city water pressure and would depend on its continued closure, when under water pressure, on the viscosity of the water, and open only when subjected to vapor pressure. An ordinary pressure safety valve set for a higher value of pressure than that of the city water mains would, in my opinion, have no application here.

M. M. McINTIRE.

Imperial, Calif.

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AN UNQUESTIONABLE conclusion regarding the necessity or usefulness of a safety valve for a hot-water heating system cannot be given unless two important facts are known, namely, the operating pressure of the system and the state law relating to pressure vessels.

In some states any inclosed vessel subject to an air, water, or steam pressure operating over 15 lb. pressure must be equipped with some type of safety valve, and in other states vessels operating with pressures at and under 15 lb. must be similarly equipped.

It is important that all pressure vessel installations meet these regulations first of all, and then the safety requirements of the particular installation.

R. L. HAMILTON.

Westpoint, Ark.

—◆—

I CERTAINLY would install a safety valve on the gas-fired hot-water boiler. In the event the water got so hot that the boiler produced steam, it would back through the main into the street main. Most water meters have disks of hard rubber composition, which will swell, get out of stroke and clog the ports of the meter if hot water passes through the meter. This will shut off the relief by way of the supply main and create an over-pressure on the piping, boiler, and tank, probably leading to an explosion. A check valve should be installed in the supply main to prevent the water backing into the street main, and a safety valve should be installed on the hot-water piping in such a manner that the boiler will not be emptied by continued blowing, so that steam will blow out when the water gets low. The outlet of this safety valve should be piped to an open sink or floor drain, or an open space.

WILMER T. MEINZER,
Flushing Hospital.

Flushing, N. Y.

—◆—

THE A.S.M.E. boiler code stipulates that water relief valves shall be placed on all hot-water heating and supply systems and be connected to the boiler or heater without intervening valves.

It is necessary to have such a relief valve so that in event of the supply from the city mains being shut off, there will be no opportunity for a dangerous pressure to build up. The fact that the city pressure is used to force the water through the house lines does not eliminate the need of a relief valve. If a valve were installed between street and heater it could be closed accidentally. The city branch feeding that particular locality could be closed intentionally or otherwise, with the heater in service. Even if the system is designed so that the water supply cannot be shut off, I believe that the safety valve is necessary.

JOHN W. WALDENVILLE.

Pittsburgh, Pa.

—◆—

IN THE event that a check valve has been installed in the mains' connection to the heater, a safety valve is necessary. Check valves are ordinarily employed in installations where there is a possibility of forcing contaminated water into the mains. If there is no other obstruction in the mains' supply than a water meter, the safety valve is not essential, as the pressure in the hot water system will not exceed mains' pressure. As a protection against excessive water-hammer caused by steam in the pipes, a safety valve on the storage tank would be of little benefit, as the water-hammer is most pronounced at the extreme end of the hot-water supply lines and not back at the tank.

Wilmington, Del. C. S. COLLIER.

▼

A Question for Our Readers

THE front head of the drum on one of our water-tube boilers has a crack at the joint that extends through six rivets. Will it be safe to weld this joint if the state inspector consents? C.V.

Suitable answers from readers will be paid for and published in the May 6 number.

▼

I CANNOT see any hazard whatever in a gas-fired hot-water heater taking water direct through the meter from the city water mains. This assumes, however, that there is no check valve or other device to prevent excess pressure resulting from the heater backing up through the meter into the water mains.

Very frequently we have found this assumption to be in error and that a check valve or similar device has been installed, not in connection with the heater, but in conjunction perhaps with a water softener or other device. Under such circumstances, it is essential that a safety valve be installed to protect the system against excess pressure created when the heater becomes overheated.

Locally, such a safety device is required by ordinance, except when the system is arranged to back the excess pressure into the city water mains. This is mentioned as evidence that our local ordinance recognizes the safety of allowing the excess pressure to back into the water mains.

This is often objectionable from the viewpoint of the water lepartment in that hot water ruins the interior parts of water meters, but we do not object, providing it does not happen frequently.

EARL E. NORMAN,
Dept. of Public Utilities.

Kalamazoo, Mich.

—◆—

A SAFETY VALVE should be used on any hot-water heating device which is not open to atmosphere at all times, for the following reasons: Should the cold-water stop valve to the heater be closed or a check valve be placed in the water line from the meter to the heater, or anything else happen which would not allow free passage of water from the heater to the city water mains, upon being heated the water will increase in volume and cause a dangerous pressure within the heater and house lines. WESLEY J. HANSEN.

Wauwatosa, Wis.

—◆—

A SAFETY VALVE is not necessary, and very few makes of safety valves will work at the pressure for which they are set. The Massachusetts Legislature in its last session killed a bill making it compulsory to install safety valves on hot-water systems.

A safety valve is necessary only where the plumbers have used their influence in getting a law to that effect passed in cities and towns of this state.

CHARLES F. EVANS.

Amherst, Mass.

—◆—

AS there have been so many hot-water-heater explosions, due to excess pressure caused by city water pressure plus heat expansion overcoming the strength of the heater, the inspectors of Massachusetts are demanding that a safety valve be installed.

LAURIC L. PALMER,
Engineer, Bancroft Hotel.

Worcester, Mass.

WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

Brine-Race Freezing System for Making Ice

AS A BRINE temperature difference of even 1 deg. shows up in irregular freezing of the ice in the cans, in opposite parts of the tank, this variation must be kept under control by circulating the brine about the cans at the proper rate. In the average installation the rate is found to equal from 8 to 14 ft. per minute, and the problem has been to accelerate this velocity of the brine over the evaporator to about 150 ft. per minute, without adding too much to the working head and corresponding horsepower of the agitator used to circulate the brine.

To meet these requirements the Frick Company, Waynesboro, Pa., has brought out the brine-race system illustrated.

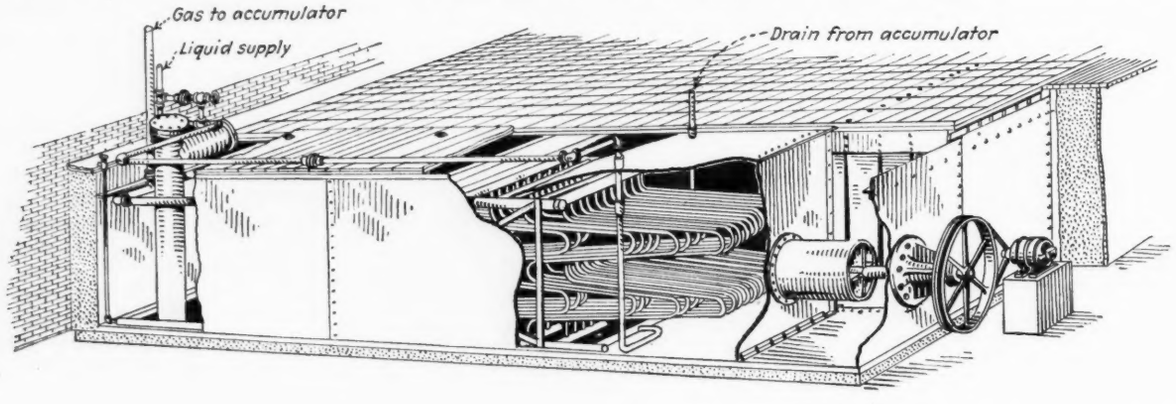
The new design includes the important features afforded by the submerged shell-and-tube brine cooler, such as compactness, rapid brine flow, unit evaporator, quick freezing of the ammonia gas, full flooded operation and adaptability to float-valve control, and at the same time presents certain other merits.

Banks of W-shaped pipe coils are welded at top and bottom to a series of short cross headers, which are joined in turn to four lengthwise headers of large size. The long headers are braced as shown, so that the whole forms a rigid, one-piece structure. The unit can be handled as a single piece, has ample distributing headers for the liquid, collecting headers for the gas and short gas passages through the coils.

The unit is placed in the partitioned brine-race inclosure, open at the top, which extends across the short side of the tank to keep as low as possible the distance through which the brine must be moved at high velocity. The brine is directed against the upper coils of the evaporator by removable baffles, set at an angle; this gives a semi-inclosed space, permitting inspection or raising of the coil unit and eliminating accumulation of the frost which would form on a metal cover in complete contact with the brine. Friction of the brine against the top is also avoided. The pumping head has been so reduced that there is but 6 in. difference in the brine levels at the agitator end, compared with a head of from 18 to 24 in. in the usual design.

The use of this particular design is not confined to ice-making plants, for it has been applied to the cooling of large quantities of water and brine for other purposes, and the unit is being installed on a low-temperature job to chill a blast of air to minus 15 degrees Fahrenheit.

Diagram of ice making tank equipped with the brine-race system



New Switching Equipment for Stand-by Service

IMPROVED automatic switching equipment for use when alternating-current generators are direct connected to gasoline engines used as an emergency power source is announced by the General Electric Company, Schenectady, N. Y. The equipment is mounted on standard-size panels and may form part of a switchboard which also takes care of power distribution. Either single- or double-unit equipments are available.

An automotive starting unit is provided for the engine and is energized from a storage battery which is kept charged by a rectifier connected to the alternating-current source. When indication is given of failure of the normal power supply the engine starts automatically and the generator supplies emergency power.

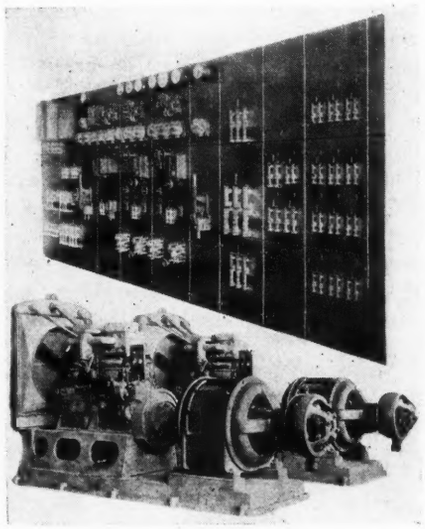
Upon return of power to normal voltage the ignition system of the engine is interrupted to shut down the unit, and the line breaker is closed, restoring normal operation. Standard protective features are also included.

In a typical installation, which includes two automatically controlled gasoline engine-driven generators, on voltage failure of the incoming line one engine-driven set starts and

is connected to the bus to carry the lighting load. The second set is started, synchronized and connected to the bus manually.

Upon return of power to the normal voltage the main incoming line breaker is closed and both generator breakers open after a time delay. The engines are then shut down by de-energizing their ignition circuits. They can be shut down manually by pulling the "open" buttons of the respective master elements of each unit.

The control is so arranged that in case of failure of the first set to respond to the starting indication within a given time the second unit will start automatically. If this occurs the first set is locked out and will require the manual resetting of a relay before it will again function automatically.

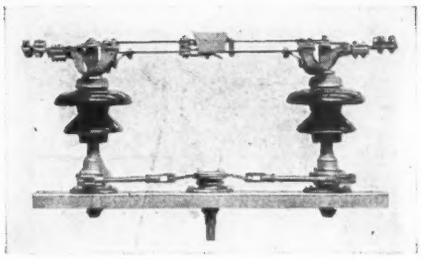


Automatic switching equipment and engine-driven alternating-current generating units

The order in which the units start may be reversed if desired. A voltage regulator adjusted to hold bus voltage is automatically connected to whichever generator is started first. If overcurrent occurs on either of the generator lines the corresponding breaker will be tripped and locked out and must be closed manually.

Side-Opening Line Switch

A SIDE-OPENING gang-operated switch for voltages up to 132,000 with both insulators rotating, has been developed by Delta-Star Electric Company, 2400 Fulton St., Chicago, Ill. A single-pole element is shown here. Double blades are provided with full-floating contacts inclosed in a sleet-proof housing. Terminal lugs are of the solderless compression type, eliminating soldering in the field. The switch illustrated is rated 37,000 volts and 600 amperes.



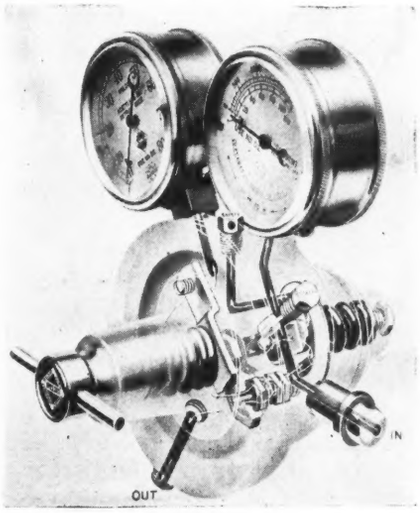
Switch in closed position

Multi-Stage Regulator for Welding Gases

IN THE multi-stage pressure regulator illustrated two separate regulators are placed in one body, the first, or primary, stage reducing the initial, or tank, pressure of 2,000 lb. to a maximum of 200 lb. The regulating unit is equipped with a German silver diaphragm, Monel metal pin, and fiber seat.

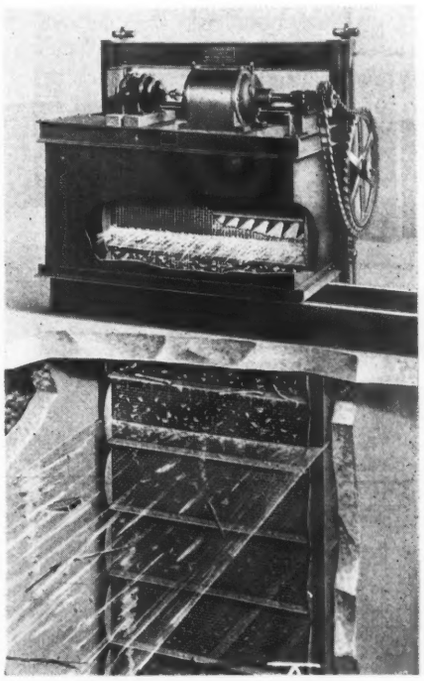
The units are connected so that the reduced pressure on the body of the first-stage regulator passes directly to the second stage, but when the tank pressure is reduced to below the 200-lb. the first stage is cut out automatically and the tank pressure is passed directly to the second stage. In this way it is possible to utilize practically all of the gas in the tank. Screens are installed to remove any foreign matter, and a dual system of vents is provided. The new regulator is put out by the Weldit Acetylene Company, 636 Bagley Ave., Detroit, Mich.

Pressure regulator with two-stage reduction



Traveling Water Screen With Improved Design of Basket

WHILE the general principle of traveling water screens is embodied in the new unit recently put out by Chain Belt Company, Milwaukee, Wis., the outward appearance of the screen itself has been definitely changed. The new unit has been designed to occupy less space for a given capacity than heretofore and to give accurate sealing at the side of the screen, as well as improved operating efficiency.



Screen is cleaned by high-pressure water spray

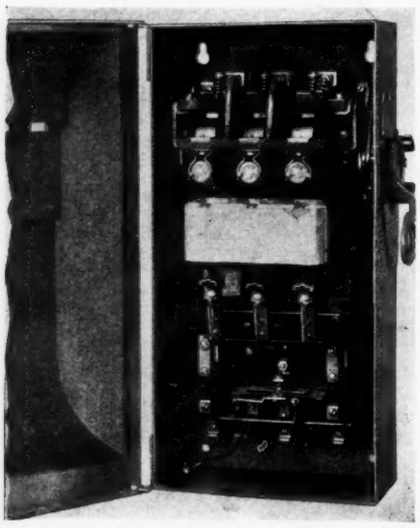
The two major improvements consist of a new basket design and a new base. The rectangular baskets hold the screen cloth (which may be of various constructions) and are, in turn, carried by two strands of hardened steel roller chain. As the submerged screen surface becomes matted with the refuse, the screen is revolved. The refuse is lifted from the intake by the upward travel of the baskets and is automatically washed into a trough by means of a high-pressure spray of water directed through the baskets from their rear.

A second important improvement is the new design of the foot wheel, which permits the use of the new extended track shoe. The latter engages the roller the instant it leaves the wheel. As a result there is no intervening space in which the roller can weave inward and cause openings between the ends of the baskets and the frame of the screen.

Combination Linestarter and Safety Switch

A COMBINATION linestarter and safety switch, Class 11-200-HD, is a recently developed product of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. This new starter occupies a minimum amount of space, and provision is made in the design for inserting, while the motor is in operation and while the door of the cabinet is closed, a plug-type meter test jack to determine the load on the machine. It can be used with or without fuses, jumpers being supplied when fuses are not used.

The safety switch has quick-break



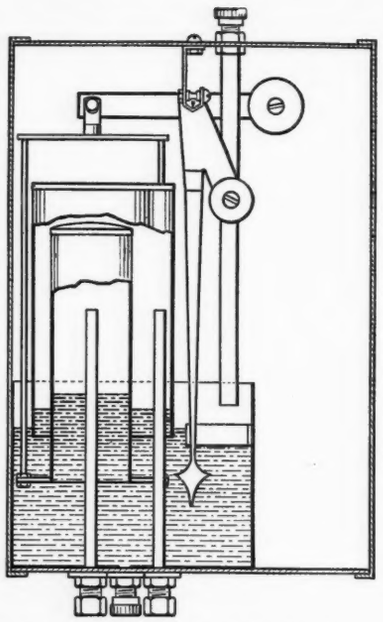
Linestarter with cover open

contacts, and the handle is interlocked with the cover, preventing opening of the door when the contacts are closed.

Differential Double-Bell Dial-Type Gages

TO ITS LINE of pointer draft gages of straight-line-movement, and the more recent dial-type made with one, two or three pointers, the Ellison Draft Gage Company of Chicago has applied a differential element to measure pressure differences, minus or plus, between two points.

The movement is of the gasometer bells beam-and-pointer type operating on three knife-edge bearings. To obtain the differential pressure two bells are used in a one-pointer element. A movable bell operates inside of a stationary bell to one side of the fulcrum, the weight of the movable bell being counterbalanced by



Double-bell, beam-and-pointer-type movement for differential pressures

a counterweight. The lower absolute pressure communicates with the movable bell from the inside and the higher absolute pressure from the outside. Thus there are two pressures acting upon the bell head, the lower pressure below the head and the higher pressure above, so that the differential pressure tends to move the bell down and the pointer over the scale.

This new gage is made in a variety of sizes. The small one-pointer's differential range is 1 in. It is sealed up to minus 2 in. and up to plus 1½ in. The larger one-pointer gage and two- and three-pointer gages offer differential ranges of 1, 1.4 or 2 in. These gages are sealed up to minus 3 in. in all the minus ranges, and at low liquid level all the differential ranges have ½-in. plus seal in excess of the scale range.

Steel Welding Rod

A NEW welding rod designated Oxweld No. 22 S.D., developed especially to meet the demand for 100 per cent joints in steel pipe having a carbon content of 0.30 to 0.40 per cent, which has recently come into use, has been announced by the Oxweld Acetylene Company, 30 East 42d St., New York City.

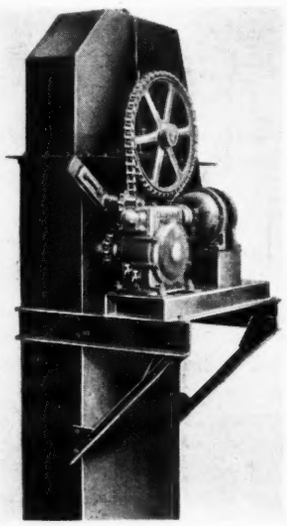
The new rod is self-fluxing and deoxidizing and forms a fusible slag that rises to the surface, where it serves as a protective coating which, although extremely thin, protects the surface of the molten bath from the oxygen of the air and thus prevents oxidation. Composition of this rod is said to prevent the strengthening element, carbon, from burning out during the welding operation. It has the ability to fuse easily into the base metal at both the sides and the bottom of the Vee.

Standardized Drive for Bucket Elevators

IN THE new standardized drive for bucket elevators recently announced by the H. W. Caldwell & Son Company, division of the Link-Belt Company, Chicago, Ill., a wide range of ratios from 3 to 15 hp. are available, making the new unit suitable for practically any elevator installation.

The first reduction of the drive is made up of a fully inclosed worm-gear speed reducer to which a standard motor is connected through a flexible coupling. The second reduction is made by a roller chain. The latter drive, in addition to providing a flexible connection between the driving unit and the elevator head shaft, makes possible reasonable speed changes in the elevator by changing the size of one or both of the sprocket wheels.

Anti-friction bearings with splash



Caldwell drive mounted on side of elevator

lubrication, hardened and ground steel worm with bronze worm gear are used in the speed reducer. The complete drive is mounted on a welded steel base made to fit the installation. For elevators with take-up head shafts an idler sprocket, as shown, is used to permit adjustment of the head shaft without lengthening or shortening the chain.

NEWS of the FIELD

Spot News

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SALE *of the SS. Jacona to the New England Public Service Company for conversion into a floating power plant was announced April 2 by the Shipping Board. At a cost of $1,000,000, the vessel will be equipped with two 10,000-kw. steam turbine-generators with four high-pressure, oil-fired boilers. The ship will be used to supply power to coast cities of Maine and New Hampshire where land facilities are not available.*

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THE FIRST HEARINGS *ever caused by the elimination of items from a prelicense accounting report were held last week by the Federal Power Commission for the Lexington Water Power Company, owner of the world's largest earth-filled dam on the Saluda River, S. C., which contends that items totaling $465,007 should not be stricken from the report.*

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CONSTRUCTION *of a 950-mile gas pipe line for the delivery of natural gas from the Texas Panhandle District to Chicago, Ill., within the next twelve months was announced April 2 by Insull, Son & Company, which have completed preliminary negotiations with six other oil and power companies to participate in the use of the gas line.*

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ONE OF THE LARGEST *deep-well pumps for city water supply in this country was recently put in operation near Reno, Nev., to supply Sparks, Nev., and part of Reno. Driven by a 400-hp. electric motor, the pump has an output of 5,500,000 gal. of water per day.*

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UNLESS *all political forecasters in Washington are mistaken, the Norris bill for government operation of Muscle Shoals will have passed the Senate by the time these words appear in print. Senator Norris began on April 2 to present the great mass of arguments saved up since his bill passed Congress in the Coolidge regime and was killed by pocket veto.*

American Welding Society to Meet in New York City, April 23-25

Boiler drum welding featured and structural and architectural applications have prominent place on spring meeting program

BOILER WELDING will have a prominent place in the program of the annual meeting of the American Welding Society to be held April 23-25 at the Engineering Societies Building in New York City. Practically one whole session will be devoted to a symposium on welded-boiler drums. C. W. Obert, honorary secretary of the A.S.M.E. Boiler Code Committee, will open the symposium with a review of the history and present status of boiler welding, with particular reference to codes, after which the meeting will be thrown open to general discussion.

It is expected that prominent members of the American Welding Society and the A.S.M.E. will join in the discussion, and that many of the comments will center on the proposed tentative code recently offered for public comment by the Boiler Code Committee of the A.S.M.E. This was published in full on pages 484 and 485 of the March 25 number of *Power*. F. R. Low, editor emeritus of *Power* and chairman of the Boiler Code Committee, will preside at this symposium.

Preceding the symposium a paper will be presented on "Construction and Operation of a New Type of Welded Limestone Kiln." It is thought that extensive experience with such kilns, subject to repeated reversals of stress at high temperature, may be of interest to the makers and users of boilers.

Other papers of particular interest to power engineers include, "The Welding of Tube Turns," "The Needs of the Metropolitan District for Instruction in Welding," "Construction Panel Heating by Welding at the British Embassy."

Architects and construction engineers have received unusual attention in this year's program, because of rapid developments in this field. Outstanding in interest will be a meeting of the Structural Steel Committee, at which great progress in this field will be revealed. J. H. Edwards, chief engineer of the American Bridge Company, will preside at this committee meeting, which will be open to all interested members.

In a session particularly devoted to architects, a prominent architect and editor, Russell Whitehead, will tell what the architect wants to know about welding. Replying in part, Webster Talmadge, heating engineer, will tell what the architect should know about pipe welding, while Prof. F. D. McKibben, consulting engineer, General Electric Company, will lead a discussion which may answer the structural questions of the architect from the point of view of electric welding. H. H. Moss, of the Linde Air Products Company, will discuss the problem from the viewpoint of gas welding.

Other structural papers will deal with fillet welds, beams welded to columns, stiffness of welded beam construction, battle-deck-welded floors, and all-welded steel barges.

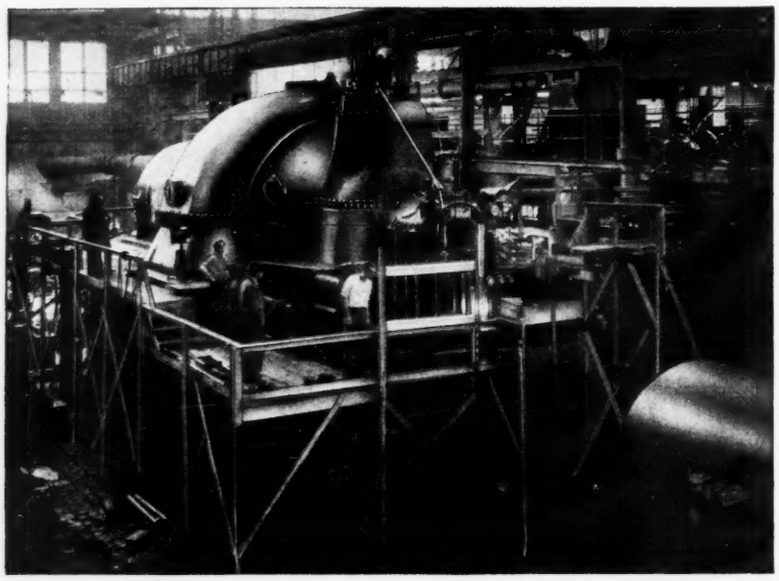
As usual, a session will be devoted to the meeting of the American Bureau of Welding, the research department of the society. Prof. C. A. Adams, first president, will preside. Social features will include a luncheon and a "stag" dinner with special entertainment.

Washington, D. C., May Build Own Power Plant

From time to time as appropriation bills for the conduct of the City of Washington are discussed, certain members of the House and Senate have made the suggestion, why not have a municipal electric light plant? Despite the fact that testimony before the House Appropriations Committee this year showed that the local electric light company has made two voluntary rate reductions in the last year, the suggestion was brought up again during the hearings on the appropriation bill for 1931.

As a result, an amendment has been incorporated in the bill authorizing the expenditure of $25,000 for a survey on the desirability of constructing a municipal light plant. This survey is to be made by engineers of the District of Columbia electrical department. A public plant already is in operation in the southern part of the city for the generation of power and heat for the Capitol, and Senate and House office buildings. An appropriation of $40,000 is provided in the deficiency bill for this plant to be used during the fiscal year of 1931.

A LARGE TURBINE-GENERATOR FOR DIXIE



This 60,000-kw. single-cylinder unit is being given its final test in the Schenectady plant of the General Electric Company previous to its shipment to Plant Atkinson of the Georgia Power Company. There is no larger unit in operation in the South

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More About the Berlin Power Conference

Unique features of recently announced plans aim to expedite sessions and render maximum opportunities to the visiting delegates

PLANS that have just been announced for handling the Berlin World Power Conference sessions mark an advance over the procedure of previous international conferences to the end that those in attendance may get the most out of it. Instead of authors reading or presenting their papers by abstract, advance studies will have been made of all papers in each of the 34 groups and a composite digest will be presented. This will conserve time by eliminating duplication and matters of common knowledge; new practices will be cited and points upon which there are differences of opinion will be emphasized. With the papers in the hands of delegates some weeks ahead of the conference, this procedure should result in profitable discussion.

The most unique feature of the plan is that the chair of each delegate will have a telephone head set which can be switched to one of three circuits carrying simultaneous translations of all speeches and discussions in French, German and English.

The scope of the conference is indicated by the titles of the 34 groups comprising over 400 papers. These groups are: Electricity in the Household and in Agriculture; Electricity in Crafts and Industry; Three-Dimensional Load Models and Current Tariffs; Economic Problems of High-Temperature Distillation; Gas Markets; Cost and Comporative Efficiency of Different Types of Energy from the Consumer's Point of View; Construction and Operation of Large Power Plants; Combined Heat and Power Supply Plants; Heat, Fuel and Power Economics in Individual Countries; Steam Turbines, Gas Turbines and Reciprocating Steam Engines; Boilers and Furnaces; The Production and Preparation of Solid Fuels; Rationalization and the Technical and Economic Problems of Water-Power Utilization; Dams; Economic Problems Relative to Power Storage on a Large Scale; The Water-Power Industry in Individual Countries; Cooperation of Different Power-Producing Plants; Construction of Large Generators and Transformers and other Electrical Machines; Switchgear, Including Automatic Control Apparatus for Power Stations and Remote Metering and Signalling Apparatus; The Transmission and Flow of Energy in Single and Multiple-Connected Networks; Earthing; Lightning Protection and the Effects of Power Lines on Telephone and Telegraph Lines.

Also, Individual Problems of Power Supply in Different Countries; World Problems of Power Supply; Problems Relating to Water Rights; Legislative and Politico-Economic Problems Relative to Power Supply; Steam and Electrically Operated Railways; Power Supply on Ships; Production of Natural and Synthetic Oil and Sales Organization; Stationary Internal-Combustion Engines and Research Work in This Connection; Automobile and Aircraft Engines; Power Transmission in Factories and on Machines and Vehicles; Research Work; Standardization Problems and the Rationalization of Statistics; Education.

In line with the economic theme of the conference addresses will be made by a number of industrialists of international standing, and a number of these addresses will be broadcast. Some will be heard on this side of the Atlantic. The program of excursions following the conference will afford delegates a rare opportunity of visiting many German industrial works that heretofore have not been open to inspection.

Giant Merger of P. G. & E. Co. With Great Western and San Joaquin

Creating one of the world's largest public utility combines, the Pacific Gas & Electric Company of San Francisco, Calif., will acquire control of the Great Western Power Company and the San Joaquin Light & Power Corporation, both California subsidiaries of The North American Company of New York City. In return the North American Company will receive 32 per cent of Pacific Gas & Electric common stock.

This agreement has been approved by the boards of directors of both companies and now awaits only the approval of the California Railroad Commission, in accordance with an application filed March 31 with the commission by the Pacific Gas & Electric Company. The combined properties will have assets of approximately $650,000,000, and will be the second largest operating public utility company in the United States, being surpassed only by the Consolidated Gas Company of New York City. During 1929 the new system had a gross revenue of $87,274,000, combined plant capacity of 1,473,000 hp. and sales of electricity exceeding 3,189,000,000 kilowatt-hours.

Rock Island Work Started

Work on the Rock Island development on the Columbia River, thirteen miles below Wenatchee, Wash., has been commenced by Stone & Webster Engineering Corporation for the Puget Sound Power & Light Company, Seattle. Camp has been established, excavation at the power house site has been started, and preliminary work on the cofferdam on the west bank is under way preparatory to the actual damming of the river to be undertaken during the low water season in late summer and early fall. Initial development calls for four units totaling 84,000 hp. while ultimate development as at present outlined will total 180,000 horsepower.

Report on Tank Explosion in Washington, D. C.

A belief that the tank explosion in a Washington five and ten cent store last November was caused by back pressure created by the sudden closing of a cock in the hot-water system, was expressed before the House Appropriations Committee recently by Maj. Donald A. Davison, assistant to the engineer commissioner of the District of Columbia. Major Davison, who was testifying before the committee in connection with the District budget for the ensuing year, explained that a reverberation or hammer effect is produced if the flow of water through a small pipe is shut off quickly.

In addition to the formal report of the disaster that was submitted to the coroner's jury, an informal investigation was made by a committee headed by Major Davison. This committee included experts from the Bureau of Standards, engineers from the Bureau of Mines, and officers from the quartermaster's office in the War Department. Major Davison stated that there was entire agreement on the committee that the explosion was caused by the action of a water-hammer shock on the insufficient welding of the tank.

The informal investigation found that there was installed under the sidewalk in front of the five and ten cent store a standard apparatus for heating hot water to be used in dish washing and in connection with the soda fountain. This consisted of a hot-water storage tank of 290-gal. capacity, a small cast-iron water-heater connected to the tank and a bypass from the connections between the hot-water heater and the tank, running through the tank, which was installed in the same vault. Major Davison stated that it was the tank that exploded.

Probably only 50 per cent of the water had an opportunity to turn into steam before the general cooling effect occurred, Major Davison said. But the pressure was great enough to blow out an entire section of the sidewalk and to bend and twist steel I-beams, in addition to throwing the heavy cast-iron furnace a distance. Under the 50-lb. pressure from the city water main, the water in the tank had to be heated to around 300 deg. before it reached the boiling point.

Keenan's Steam Tables Published

The long-awaited steam tables by Joseph H. Keenan, sponsored by the Special Research Committee on the Thermal Properties of Steam of The American Society of Mechanical Engineers, have just been published in book form by the society. Mr. Keenan is assistant professor of mechanical engineering at Stevens Institute of Technology and was formerly with the turbine engineering department of the General Electric Company. The development of these steam tables is owing to the confusion which has resulted from the necessity of carrying forward design in the field of steam-power engineering to pressures of 500 to 3,200 lb. per square inch on the basis of steam tables whose reliable experimental sources in the superheat region extended to less than 200 lb. per square inch. These tables differed radically from each other outside this limit and in themselves emphasized the need for further experiment.

From this need has sprung an extraordinary activity in steam research that is international in scope. It is believed that these new tables, covering the field of present-day operation and development, will be a valuable aid in the design of modern apparatus.

News of Canada

Ontario to spend $27,901,000 for power development; purchases Dominion Power and Transmission Company — Work progresses rapidly at Ruskin project

THE ONTARIO Hydro-Electric Power Commission plans to spend $27,901,000 on development work during the current fiscal year. The estimates as brought down in the provincial legislature on March 26 provide for an expenditure of $18,045,000 on the Niagara system. Development work at Chats Falls, on the Ottawa River, is estimated to cost $7,225,000, and the Carillon development, also on the Ottawa River, $500,000. The Georgian Bay system estimates total $1,260,000, of which $900,000 is for development work at the Musquash plant. The St. Lawrence, Ottawa and Rideau, Eastern and Madawaska systems call for an expenditure of $785,000. The Thunder Bay division estimates total $595,000, with development work at Alexander and Cameron Falls accounting for $450,000. The Central Ontario division estimates total $819,000. Of this, $515,000 is for transformer stations and transmission lines at Kingston and Belleville. The Northern Ontario systems call for an expenditure of $4,845,000, of which $2,500,000 is for development work on the Mississagi River, $10,000 at Ear Falls, and $350,000 at Wahnapitae.

IN THE ONTARIO Legislature on March 26 Premier Ferguson announced the purchase by the Ontario Hydro-Electric Commission of the Dominion Power & Transmission Company for $21,000,000. This company owns and

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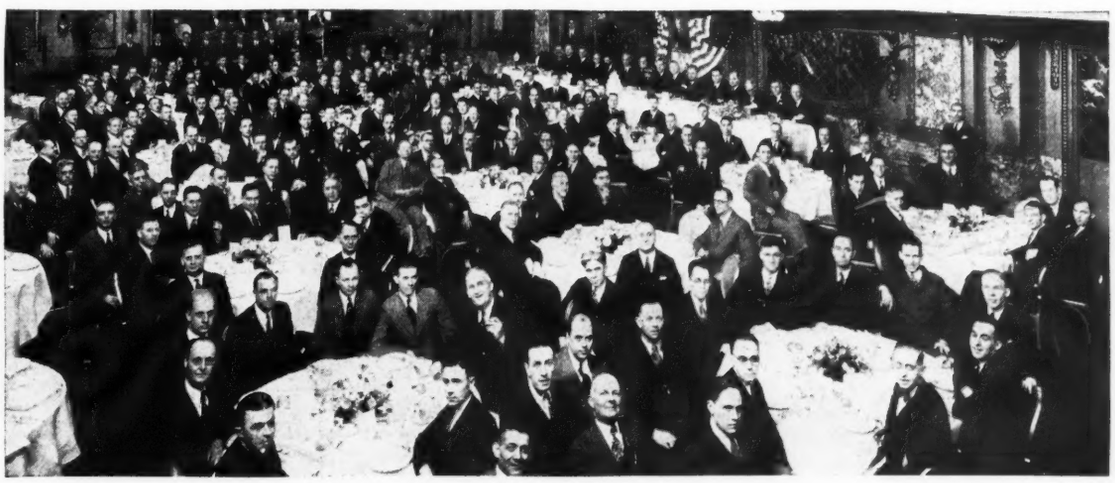
BYLLESBY ENGINEERS' ANNUAL DINNER IN CONGRESS HOTEL, CHICAGO



This was the concluding event of the fifth annual convention of the engineering department of the Byllesby Engineering and Management Corporation held from March 24 to 26 to review and analyze recent Byllesby projects

operates a 40,000-kva. power plant at De Cew Falls, together with power, light and radial companies in and around Hamilton. The company was one of the few large concerns still operating in Ontario under private ownership. The power station at De Cew Falls was one of the first power developments in Ontario.

GOOD PROGRESS is being made on the power house of the British Columbia Electric Railway Company's Ruskin project on the Stave River. Erection of the steel frame has been started, and the steel penstock also is being erected. The turbine casing is assembled and is being riveted. Excavation of the two penstock tunnels has been completed, and the lining of the No. 1 tunnel has been started. Excavation for the dam is still under way, but it is expected that concreting will be started this month.

The Ruskin power plant will have an initial capacity of 47,000 hp., and an ultimate capacity of 188,000 hp. It is expected to be completed in 1930.

Newcomen Society Meets in New York

American members of the Newcomen Society held a dinner meeting at the Engineers' Club in New York City on April 4. Contrary to the usual custom of meeting simultaneously with the parent organization in England, the American section took advantage of the presence in this country of Loughnan St. L. Pendred of London and Conrad Matchoss of Berlin to hold a special dinner in their honor. Short talks of a historical nature in keeping with the purposes of the society were made by the distinguished guests.

Both are visiting the United States to participate in the fiftieth anniversary celebration of the American Society of Mechanical Engineers. Mr. Pendred, editor of *The Engineer*, is president and a founder member of the Newcomen Society, and president of the British Institution of Mechanical Engineers. Dr. Matchoss is a member of the society, director of the Verein Deutscher Ingenieure and professor of engineering history at the Charlottenburg Technical High School.

Fights Use of "Carborundum" as Common Noun

In its campaign against the growing tendency on the part of authors to treat the word "Carborundum" as a common or generic noun, the Carborundum Company of Niagara Falls, N. Y., announces that the word "Carborundum" is a trademark of that company, registered in the United States and many foreign countries and is applied by it to its range of products; abrasive, refractory, mechanical and electrical. The Carborundum company states that the proper term is silicon carbide, unless a specific Carborundum brand product is referred to.

COMING CONVENTIONS

American Society of Mechanical Engineers. Semi-Annual meeting at the Hotel Book-Cadillac, Detroit, Mich., June 9-12, 1930. Secretary, Calvir Rice, 33 West 39th St., New York City.

American Institute of Electrical Engineers, District meeting at Springfield, Mass., May 7-10. Annual summer convention at Toronto, Canada, June 23-27. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

American Society of Heating & Ventilating Engineers. Annual summer meeting at the Curtis Hotel, Minneapolis, Minn., June 23-25. Secretary, A. V. Hutchinson, 33 West 39th St., New York City.

American Society of Refrigerating Engineers. Annual spring meeting at the Atlanta Biltmore Hotel, Atlanta, Ga., May 7-9. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Society for Testing Materials. Annual meeting at Haddon Hall, Atlantic City, N. J., June 23-27. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Welding Society. Annual meeting at society headquarters in New York City, April 22-25. Secretary, M. M. Kelly, 33 West 39th St., New York City.

American Refractories Institute. Annual spring meeting at The Greenbrier, White Sulphur Springs, W. Va., May 19-20. Secretary, Dorothy Texter, 2202 Oliver Bldg., Pittsburgh, Pa.

Association of Iron and Steel Electrical Engineers. Annual convention and iron and steel exposition at Broadway Auditorium, Buffalo, N. Y., June 16-20. Managing director, John F. Kelly, Empire Building, Pittsburgh, Pa.

Canadian Electrical Association. Annual Convention at the Manoir Richelieu via the S.S. "St. Lawrence," June 11-13, 1930. Secretary, H. M. Lyster, 405 Power Building, Montreal, Quebec.

International Congress for General Mechanics at Liege, Belgium, Aug. 31 to Sept. 7, 1930. For information address Alb. Schlag, 4 Place Saint-Lambert, Liege, Belgium.

International Railway Fuel Association. Annual meeting at the Hotel Sherman, Chicago, Ill., May 6-9. Secretary, C. T. Winkless, Room 700, LaSalle St., Station, Chicago, Ill.

National Electric Light Association. Annual convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

National Oil and Gas Power Meeting, under auspices of A.S.M.E. Oil and Gas Power Division and Pennsylvania State College, will be held at State College, Pa., June 12-14. Chairman, L. H. Morrison, c/o *Power*, 10th Ave. and 36th St., New York City.

National Power Show. Held in connection with the International Textile Exposition at Mechanics Building, Boston, Mass., April 28 to May 3. For information, write to the New England Association of Commercial Engineers, 53 Devonshire St., Boston, Mass.

Second Plenary World Power Conference. Convenes at Berlin, German, June 16-25. Chairman of the American Committee, O. C. Merrill, Edmunds Building, Washington, D. C.

Personals

R. S. COULTER, who for the past eleven years has been combustion engineer at the Sparrow's Point plant of the Bethlehem Steel Company, has resigned this position to devote his entire time to his private practice of consulting combustion engineering. His headquarters will be located at Lebanon, Pa.

LESTER E. F. WAHRENBURG, recently connected with the Byllesby Engineering & Management Corporation as mechanical engineer, has become associated with the Burrell-Mase Engineering Company of Pittsburgh, Pa.

H. R. MCCLYMONT, consulting mechanical and electrical engineer with Kerry & Chace, Ltd., for many years, has become a partner in the McMaster-Jacob Engineering Company, Ltd., of Toronto, Canada.

R. E. HELLMUND, chief electrical engineer of the Westinghouse Electric & Manufacturing Company, has just been elected a member of the board of directors of the German Institute of Electrical Engineers, of which THOMAS EDISON is an honorary member.

SAMUEL T. WAGNER, member of the executive committee of the American Society for Testing Materials, has been recently appointed a member of the Pennsylvania state board for the registration of professional engineers.

HENRY BLAKE WOOD has been appointed chief electrical engineer of the Stone & Webster Engineering Corporation, Boston, Mass. A graduate of Purdue University, Mr. Wood was employed by the General Electric Company for a number of years before joining the Stone & Webster organization in 1917 as an engineer in the electrical division. In 1926 he was made assistant to the chief electrical engineer. His work has embraced a wide variety of public utility and industrial undertakings in this country and abroad, among which was a hydro-electric investigation in Japan in 1928.

A. C. KLEIN has been promoted to chief mechanical engineer of the Stone & Webster Engineering Corporation, Boston, Mass. Other promotions recently announced by the company are: W. N. PATTEN, vice-president, has been appointed consultant on engineering and construction activities and J. R. LOTZ has been placed in charge of all construction operations and construction personnel. R. T. BRANCH and B. M. COWAN have been appointed construction managers. E. LACROSSE has been appointed principal assistant engineering manager. R. E. ARGERSINGER, formerly chief electrical engineer; H. L. BUNCE, formerly design manager; and A. B. WILLIAMS, formerly chief mechanical engineer, have been appointed assistant engineering managers.

Business Notes

JAMES D. ANDREW, consulting engineer, is now located at 84 Pine St., New York City.

TUBE-TURNS, Inc., Louisville, Ky., announces the following appointments as distributors of its products: E. F. Keating Company, 452 Water St., New York City; Himelblau-Agazim & Company, 30 North Dearborn St., Chicago, Ill., Stewart Machinery Company, Buder Building, St. Louis, Mo. It is also announced that W. P. Curley and A. L. Breyvogel will continue as managers of the New York and Chicago branch offices, respectively.

TRUMBULL ELECTRIC MANUFACTURING COMPANY, Plainville, Conn., has moved its San Francisco, Calif., office from 595 Mission St. to 432 Fourth Street.

DELTA-STAR ELECTRIC COMPANY, Chicago, Ill., announces that Hugo Van Rosen, for several years in charge of the Boston office, has been transferred to the Chicago office in the sales engineering department.

TREADWELL ENGINEERING COMPANY, Easton, Pa., announces that the HAHN ENGINEERING COMPANY has ceased to be a division of the Lancaster Iron Works, Inc., and is now a division of the Treadwell company, with main offices and works in Easton, Pa. The New York office is located at 90 West St., and additional offices will be established as soon as possible.

ELECTRIC MACHINERY MANUFACTURING COMPANY, Minneapolis, Minn., announces the removal of its Baltimore, Md., office from 432 North Calvert St. to 600 North Calvert Street.

METER DEVICES COMPANY, Canton, Ohio, is now located in its new factory at 3115 Tuscarawas West. This company was formerly identified with the Superior Switchboard & Devices Company of the same city. T. J. Newman, former president of the Superior company, is now at the head of Meter Devices Company.

CHICAGO PNEUMATIC TOOL COMPANY, New York City, announces the opening of the following new branch offices: Oklahoma City, Okla., Perrine Building; Tulsa, Okla., 327 Philcade Building, and Houston, Texas, Merchants & Manufacturers Building.

SAMUEL M. GREEN COMPANY, Springfield, Mass., has become associated with FLETCHER-THOMPSON, INC., of Bridgeport, Conn., and Newark, N. J., and the CHAS. H. MOORES COMPANY of New York City. All three firms have conducted business as engineers and architects for many years, and the present heads of each organization will continue to serve their particular clients in the same manner as before.

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With the SOCIETY SECTIONS

Anthracite - Lehigh Valley Section. Joint meeting with the Student Branch at Lehigh University and Lafayette College on April 10 at 8 p.m. Subject: "Welding," by Frank P. McGibben, consulting engineer, General Electric Company.

Detroit Section. Meeting at the Detroit Engineering Society Club House on April 21 at 8 p.m. Subject: "Industrial Power Plants," by Garrett Burgess, president, Garrett Burgess, Inc.

Florida Section. Annual meeting of the Florida Engineering Society at Ocala, Fla., on April 18 at 1 p.m. Annual election of officers.

Metropolitan Section. Inspection of Macy's plant, 34th St. and Broadway, New York City, on April 30 at 7 p.m. Meeting at 8:15 p.m. in the Engineering Societies Building. Sponsored by the A.S.M.E. Oil and Gas Power Division. Subject: "Diesels in Store Buildings," by George Pogue, Eastern sales manager, Fulton Iron Works Company.

Philadelphia Section. Meeting at the Engineers Club on April 22 at 8 p.m. Subject: "Design and Construction of Deepwater Power Station," by K. M. Irwin, mechanical engineer, United Gas Improvement Company.

Worcester Section. Meeting in Sanford Riley Hall, Worcester Polytechnic Institute on April 8. Subject: "The Development of Coal-Firing Equipment," by F. H. Daniels, president, Riley Stoker Corporation.

A.I.E.E., Niagara Frontier Section. Meeting at Niagara Falls Power House No. 2 on April 18. Subject: "Use of Regulators in Industry," by J. H. Ashbaugh, regulator engineer of the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

Midwest Bituminous Coal Conference. Held under the direction of the Engineering Schools of Purdue University, Coal Trade Association of Indiana and Illinois Coal Bureau, at Lafayette, Ind., April 9-11. Chairman, W. A. Knapp, Purdue University, Lafayette, Ind.

New England States Association of the National Association of Power Engineers. Annual convention and exhibition of power machinery at the State Armory, Salem, Mass., June 19-20, 1930. Secretary, E. S. Daniels, 113½ Bridge St., Salem, Mass.

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Trade Catalogs

GAGES—Bulletin 13 just issued by the Ellison Draft Gage Company, Chicago, Ill., describes the new cover-type U-gages that have been designed for direct reading of pressures—minus, plus or differential—of air and gases for both stationary and portable use.

CHAINS — Complete information needed to design, install and maintain Morse chain drives is contained in Bulletin No. 38 just issued by the Morse Chain Company, Ithaca, N. Y. This data book also goes into the subjects of chain speed reducers and flexible couplings at some length, showing their practical application to every-day power transmission jobs.

STELLITE — "Properties of Haynes Stellite" is the title of a 30-page illustrated booklet published by the Haynes Stellite Company, Kokomo, Ind., which presents a general description of the Haynes Stellite alloys.

HEATING—The Lee air-heating system, a centralized system for heating industrial buildings, is fully described in a 16-page, illustrated bulletin, No. 130, just published by the Lee Air Heater Company, 222 West Rayen Ave., Youngstown, Ohio.

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Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.20 @ $2.30
Kanawha	Columbus	1.35 @ 1.50
Smokeless	Cincinnati	1.75 @ 2.25
Smokeless	Chicago	1.75 @ 2.25
S. E. Kentucky	Chicago	1.40 @ 1.60
Steam	Pittsburgh	1.40 @ 1.65
Gas Slack	Pittsburgh	.90 @ 1.10
Big Seam	Birmingham	1.35 @ 1.50
Anthracite		
(Gross Tons)		
Buckwheat	New York	$2.70 @ 3.00
Barley	New York	1.40 @ 1.50

FUEL OIL

New York—Apr. 3, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75@5c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Mar. 28, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.520 per bbl., or 42 gal.; 26@28 deg., $1.620 per bbl.; 28@30 deg., $1.720 per bbl.; 30@32 deg., $1.77 per bbl.; 32@36 deg., gas oil, 4.276c. per gal.; 37@40 deg., distillate, 4.98c. per gal.

Pittsburgh — Apr. 1, f.o.b. local refinery, 30@34 deg., fuel oil, 4.5@4.75c. per gal.; 36@40 deg., 4.75c.

Philadelphia—Mar. 11, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati — Apr. 1, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Mar. 31, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 80c. per bbl.; 26@30 deg., 90c.@95c. per bbl.; 30@32 deg., $1.05@$1.10 per bbl.

Boston—Mar. 29, tank-car lots, f.o.b., 12@14 deg., Baumé, 3.3c. per gal.; 28@32 deg., 5c. per gal.

Dallas—Mar. 22, f.o.b. local refinery 26@30 deg., $1.25 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Colo., La Junta — City Council, is having plans prepared for the construction of a pumping plant in connection with waterworks. Douglass & Thwaits, Continental Oil Bldg., Denver, are consulting engineers.

Fla., Jacksonville—Florida Fruit & Produce Co., N. Dwoskin, Mgr., 416 West Bay St., plans the construction of a cold storage plant.

Fla., Tallahassee — State Bd. of Control, awarded contracts for the construction of central heating plants, one to Hanner Construction Co., $21,965, and one to W. Denson, Jacksonville, $19,035.

Ind., Evansville—Weil Packing Co., awarded contract for the construction of a 2 story, 60 x 100 ft. packing plant, including beef cooling rooms, cold storage plant, etc., to C. Kanzler & Son. Estimated cost $50,000.

Ind., Fort Wayne—Wayne Knitting Mills, had plans prepared for the construction of boiler plant including three boilers. Estimated cost $225,000. Private plans.

Ia., Ottumwa—City has been granted permit by the Federal Power Commission to construct a hydro-electric project on the Des Moines River, 3,600 hp. capacity.

La., New Orleans—Sewage & Water Board, received lowest bids for furnishing and installing two frequency change sets, transformers, switchboard panels, instruments and accessories from Fairbanks Morse & Co., 1100 St. Charles St. (1) $98,207 and (2) $127,000.

Mass., Boston—Edison Electric Illuminating Co., 39 Boylston St., awarded contract for additions and alterations to power station on Scotia St. to J. F. Fitzgerald Construction Co., 38 Chauncy St., also on L St. to F. T. Ley Co., Statler Bldg. Estimated total cost $40,000.

Mass., Westwood — Town will soon receive bids for the construction of a water supply system including wells, pumping system, mains, etc. Estimated cost $175,000. Dedham Water Co., High St., Dedham, is engineer.

Mich., Allegan—City has been granted permit to construct a hydro-electric plant, 3,600 hp. capacity on the Kalamazoo River in Allegan county.

Mich., Detroit—Dept. of Water Supply, 735 Randolph St., awarded contract for electrical switching equipment to be used for Springwells pumping station to Westinghouse Electric & Mfg. Co., 5757 Trumbull Ave. $314,368.

Mich., Detroit—Public Lighting Commission, East Atwater St., awarded contract for eight 24,000 v. metal clad switching untis with control equipment for Joy Rd. sub-station to Westinghouse Electric & Mfg. Co., 5757 Trumbull Ave. $79,000.

Neb., Omaha—Father Flanagan's Boys Home, West Dodge St., is having preliminary plans prepared for the construction of power and machinery buildings. Estimated cost $50,000.

N. J., Rochelle Park—City awarded contract for the construction of a sewage treatment plant to Echo Contracting Co., 485 Main St., Fort Lee, and for pumping plant to J. Sigretto, Carlstadt.

N. J., Trenton—State Bd. of Education, will readvertise soon for bids for the construction of a group of buildings, including power house, etc., at State Teachers College, Hillwood Lakes. Guilbert & Betelle, 20 Branford Pl., Newark, are engineers. Formr bids rejected.

New York—Rochester Gas & Electric Corp., 89 East Ave., Rochester, has been granted permit by Public Service Commission to construct a hydro-electric development on Genesee River at Mount Morris, also high tension electric power transmission line from Rochester to sub-station on High Banks Rd. in Mount Morris and from Mount Morris sub-station to existing line from Perry to Elmira.

N. Y., Brooklyn—Dpt. of Sanitation, plans the construction of a temporary sewage treatment plant and pumping station at Flatlands and Ralph Aves. Estimated cost $800,000. A. J. Griffin, Municipal Bldg., is architect.

N. Y., Brooklyn — Dept. of Water Supply, Municipal Bldg., New York, plans the construction of a waterworks pumping station at West 24th St. and Neptune Ave. here. Estimated cost $150,000. M. D. Metcalf, Bedford and Atlantic Aves., is engineer.

N. Y., New York—Metropolitan Life Insurance Co., 1 Madison Ave., plans power unit in 100 story office building at 25th St. and 4th Ave. D. A. Waid, 1 Madison Ave., is architect. H. W. Corbet, 130 West 42nd St., is associate architect. Purdy & Henderson, 45 East 17th St., are structural engineers. C. Place, 420 Lexington Ave., is heating and ventilating engineer. Kaiser, Muller & Davis, 101 Park Ave., are electrical engineers. Starrett Bros., 101 Park Ave., are contractors.

O., Apple Creek—Dept. of Welfare, A. T. Connar, Ninth and Oak Sts., awarded contract for the construction of two cottages and 60 x 72 ft. power house for Institution for Feeble Minded here, to R. H. Evans & Co., Atlas Bldg., Columbus. Estimated cost $454,360.

O., Northfield—Cleveland Electric Illuminating Co., W. H. Hartman, Purch. Agt., 75 Public Sq., Cleveland, is receiving bids for the construction of an electric sub-station, here. Estimated cost $40,000. Private plans.

Pa., Holtwood — Safe Harbor Water Power Co., has been granted permit to construct a hydro-electric plant on the Susquehanna River to develop 539,000 hp. Estimated cost approximately $30,000,000. Work on project started.

Pa., Indiana—R. G. Howard, Dep. National Bank Bldg., DuBois, Archt., will receive bids until Apr. 14 for the construction of a 3 story hospital, including power house, laundry, etc., here, for Indiana Memorial Hospital. Estimated cost $150,000

Pa., Pittsburgh—Dept. of Public Works, City-County Bldg., will soon award contract for the construction of Ross pumping station in connection with waterworks. C. M. Reppert, City-County Bldg., is engineer.

Pa., Shaler—Shaler Township, M. C. Smith, Clk., received lowest bid for the construction of a pumping station including 300 g.p.m. centrifugal pumps, etc. in connection with waterworks from Fayette Contracting Co., Brownsville. $126,845.

Texas—Santa Maria Water Control & Improvement Dist., Brownsville, plans an election Apr. 12 to vote $50,000 bonds for the construction of an irrigation project including the installation of a pumping unit, etc.

Tex., Caldwell—City will receive bids after Apr. 20 for electrifying steam pumping plant and constructing retaining reservoir, etc., in connection with waterworks. Estimated cost $60,000. J. Rady, Waco, is engineer.

Tex., Galveston—Treasury Dept., office of J. A. Wetmore, Supervising Architect, Washington, D. C., will receive bids until May 2 for the construction of a 3 story marine hospital, including heating and refrigeration plants, laundry, etc., here. Estimated cost $740,000.

Tex., McCamey—Dixie Oil Co., c/o F. E. King, Dist. Supt., plans to rebuild electric light plant including equipment recently destroyed by fire. Estimated cost $25,000 to $30,000. Private plans.

Wash., Edmonds—Union Oil Co., W. W. McAfee, Northern Div. Mgr., plans to expend $200,000 for addition to storage facilities, boiler house, etc., here.

Equipment Wanted

Air Compressor — New York, N. Y. — Borough of Manhattan, J. Miller, Pres., will receive bids until Apr. 10 for portable air compressor, etc.

Boilers—Los Angeles, Calif.—County Supervisors, will receive bids until Apr. 14 for two 500 hp. water tube boilers for power plant at County General Hospital.

Condensers—Brooklyn, N. Y.—Signal Supply Officer, New York General Depot, 58th St. and First Ave., will receive bids until Apr. 15 for condensers, Signal Corps type CA-127, working voltage 5,000 v., Dubilier type 667, or Faradon type UC-1842 with No. 13-B case or equal; condensers Signal Corps type CA-132, working voltage 2,000 v., Dubilier type 667 or Faradon type UC-2299 with 13-B case or equal; Resistor, Signal Corps type RS-78, 27,000 ohms plus or minus five per cent.

Engine and Generator Set — Fort Mason, Calif.—Quartermaster Supply Office, will receive bids until Apr. 21 for one 225 hp. lightweight highspeed, direct acting 2 or 4 cycle solir or air injection marine Diesel engines with accessories and fittings, also one 15 kw. Diesel engine generator set, d.c. 115 v. with switchboard, electrical fixtures, pumps, etc.

Generator, Transformers, Switchboards, etc.—New Orleans, La.—Sewerage & Water Board, will receive bids until May 21 for one motor generator, three transformrs, 12 truck type switchboards, and black enameled slate panels and all accessories.

Insulator Strings—Wellington, N. Z.—Dept. of Public Works, Supplies & Tenders Committee, will receive bids until July 8 for 1,250 suspension insulated strings, complete with fittings.

Motor—Whittier, Calif.—City, D. E. Allen, Clk., plans to purchase a 100 hp., 400 v., 50 cycle, 960 r.p.m. vertical induction motor.

Oil Burning Equipment, etc.—Eureka, Calif.—County, F. M. Kay, Clk., will receive bids until Apr. 15 for the installation of oil burning apparatus and other necessary mechanical boiler house and laundry equipment together with steam line connections to hook up existing boilers to various underground steam line conduits of county hospital (now under construction).

Industrial Projects

Calif., Los Angeles—Arco Co., awarded contract for the construction of a 2 story lacquer and varnish factory on 59th St. to The Austin Co. of California, 777 East Washington St. Estimated cost $75,000.

Conn., Meriden—International Silver Co., J. A. Hutchinson, 48 State St., is having plans prepared for the construction of a 1 story, 40 x 300 ft. factory. Estimated cost $50,000. Private plans.

Mass., Cambridge (Boston P. O.)—General Radio Co., 30 State St., awarded contract for the construction of a 4 story factory to W. M. Bailey Co., 88 Broad St., Boston. Estimated cost $80,000.

Mass., Everett (Boston P. O.)—Merrimac Chemical Co., 148 State St., Boston, will soon receive bids for the construction of a 3 story, 85 x 110 ft. chemical plant here. Estimated cost $40,000. Private plans.

Mass., Foxboro—The Foxboro Co., Neponset Ave., is receiving bids for a 2 story addition to factory for the manufacture of gauges and thermometers, etc. Estimated cost $40,000. Private plans.

N. J., Bloomfield—T. Oakes & Co., 225 Belleville Ave., will build a 3 story addition to factory for the manufacture of woolens. Estimated cost $40,000. J. F. Scrimshaw, 526 Elm St., Arlington, is architect. Work will be done by separate contracts.

N. J., Harrison—Driver-Harris Co., Middlesex St., will receive bids about May 15, for a 1 and 2 story addition to factory. Estimated cost $250,000. J. A. Finegan, 776 Broad St., Newark, is architect.

N. J., Linden—Commercial Steel Equipment Corp., 1024 Elizabeth Ave., will build a 1 story factory. Estimated cost $40,000. A. J. Silberstein, 868 Broad St., Newark, is architect. Work will be done by separate contracts.

N. J., Newark—P. B. West, 24 Commerce St., Archt., will receive bids about Apr. 15 for the construction of a 2 story factory on Maple Pl. for General Alloy Co., 188 New Jersey R.R. Ave. Estimated cost $40,000.

N. Y., Hastings-On-Hudson—American Brass Co., Grand and Meadow Sts., Waterbury, Conn., is having plans prepared for addition to wire and cable drawing plant, here. Estimated cost $450,000. Private plans.

N. C., Asheboro—Bessong Hosiery Mills, Inc., will soon receive bids for a 1 story, 98 x 137 ft. addition to dye house and boiler house. Lockwood Greene & Co., Charlotte, are engineers.

Pa., Meadville — Hookless Fastener Co., L. Walker, Pres., East Arch St., will receive bids until Apr. 15, for a 3 story, 50 x 70 ft. factory. Wilbur Watson & Associates, 4614 Prospect Ave., Cleveland, O., are architects.

Pa., Ridgway—Viking Metal Products Co., E. T. Johnson, Pres., Jamestown, N. Y., will scon receive bids for the construction of a 1 story, 120 x 280 ft. factory here. Estimated cost $40,000. Private plans. C. L. Juers, c/o Hyde Murphy Co., Race St., Ridgway, Director.

R. I., Pawtucket—U. S. Finishing Co., P. J. Holton, Engr., awarded contract for the construction of a silk mill to A. F. Smiley Co., 202 Oak Hall Bldg., Pawtucket. Estimated cost to exceed $40,000.

Tenn., Memphis—DeSoto Paint & Varnish Co., East Railroad Ave., awarded contract for the construction of a 1 story paint factory, including 35 x 35 ft. boiler room and shipping room, tank room, warehouse, etc., at Railroad Ave. and East St., to B-W Construction Co., 720 Cass Ave., Chicago, Ill. Estimated cost $25,000.

Wis., Milwaukee—F. F. Drolshagen, 447 Virginia St., Archt., is receiving bids for the construction of a tannery for Pfister Vogel Leather Co., 447 Virginia St.

Wis., Sheboygan—Wisconsin Power & Light Co., 900 Gay Bldg., Madison, awarded contract for a 2 story, 66 x 275 ft. freight station and service building here to L. F. Schroeder Construction Co., Fond du Lac.

Ont., Peterboro—Canadian General Electric Co., Park St., awarded contract for the construction of a 1 story, 160 x 400 ft. factory for the manufacture of switchboards to T. A. Brown Co. Ltd., Ontario Bldg., Toronto. Estimated cost $175,000.

Ont., Toronto—J. F. Raw Co. Ltd., 56 Adelaide St. E., awarded contract for the construction of a 5 story blueprinting plant, instrument factory to A. Wickett Ltd., 16 Saulter St. Estimated cost $100,000.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

LOWER prices on wrought-steel pipe went into effect Apr. 1, with the new Pittsburgh basing card. Discounts on 1 to 3-in. butt-weld rose 2 points, to 64 per cent, while on galvanized, the increase was 2 points, to 52½ per cent from list. The increased discounts, however, apply on jobbers carloads, warehouse quotations remaining unaffected in the principal cities. Prices on flexible cord are lower this month, while higher figures obtain on New York warehouse shipments of black elbows and couplings.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net) 60c. per ft.
Common, 2½-in., cotton, rubber-lined, 80c. per ft., list, less		50%
	Air—Best grade	
¾-in., per ft.	3-ply $0.30	4 ply $0.36
	Steam—Discounts from List	
First grade 40%	Second grade 45%	Third grade 50-10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade 50% Second grade 60%

LEATHER BELTING—List price, 24c. per lin.ft., per inch of width, for single ply, at New York warehouses:

Grade	Discount from list
Medium	30-10%
Heavy	30%

RAWHIDE LACING—For cut, best grade, 30-5%; 2nd grade, 45-5%. For laces in sides, best, 57c. per sq.ft.; 2nd, 52c., net. Semi-tanned, cut, 30-5%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$0.90
Asbestos for high-pressure steam, ⅛ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.45
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts from list at New York warehouses are as follows:

85% magnesia, high pressure		40 %
Asbestos, air cell, for low-pressure heating and return lines	4-ply	65 %
	3-ply	67½ %
	2-ply	70 %

PORTLAND CEMENT—New York, $2.30 per bbl., without bags, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.30 per 100 lb. in lots up to 3,999 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	13.00	16.00	15.00
Colored	9.50	12.00	12.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed white wipers, as follows:

Chicago (100 lb. bales)	$0.16
New York (100 lb. bales)	.12½
Cleveland (per thousand)	38.00

LINSEED OIL—These prices are for raw oil in barrels, f.o.b., in 1 to 4 bbl. lots:

	New York	Cleveland	Chicago
Per pound	$0.15	$0.164	$0.154

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b., New York:

	Dry	In Oil
Red	$13.75	$15.25
White	13.75	14.25

RIVETS—The following quotations apply on fair-sized orders from warehouse:

Tank rivets, ⅞-in. diameter and smaller, list (Apr. 1, 1927) less 60% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., round head, per 100 lb.:

New York	$4.50*
Chicago	4.00
Pittsburgh mill	3.10

*This price is for full kegs; broken-kegs are $6.00 per 100 lb.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome ore, ground, 40@50%, Cr_2O_3, in bulk	per net ton	22@25
Chrome ore, ground, 40@50%, Cr_2O_3, in sacks	per net ton	26@29
Chrome ore, crude, 40@50%, Cr_2O_3	per net ton	18.00@22.50
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa.	per M	43.00
Clay brick, 1st quality, 9-in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Colorado	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38

BABBITT METAL—Delivered in case lots from New York warehouse, on orders of 100 lb. or over, cents per pound:

Genuine, highest grade	56.00
Commercial genuine, intermediate grade	42.00
Anti-friction metal, general service	31.00
No. 4 babbitt, f. o. b.	11.25

COLD DRAWN STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.40	$3.65	$3.60
Flat or square	3.90	4.15	4.10

BOILER FITTINGS—F.o.b. warehouse, Jersey City, N. J., discounts from list:

Copper ferrules	70%
Boiler flanges	65–5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following basing discounts from list are for large mill lots at Pittsburgh mill:

BUTT WELD

	Steel			Iron	
Inches	Black	Galv.	Inches	Black	Galv.
1 to 3	64%	52½%	1 and 1¼	31%	15%
LAP WELD					
2	57%	45½%	2	23%	9%
2½ to 6	61%	49½%	2½ to 3½	28%	13%
7 and 8	58%	45½%	4 to 6	30%	17%
9 and 10	56%	43½%	7 and 8	29%	16%
11 and 12	55%	42½%	9 to 12	26%	11%
BUTT WELD, EXTRA STRONG, PLAIN ENDS					
1 to 1½	62%	51½%	1 to 2	34%	18%
2 to 3	63%	52½%			
LAP WELD, EXTRA STRONG, PLAIN ENDS					
2	55%	44½%	2	29%	13%
2½ to 4	59%	48½%	2½ to 4	34%	20%
4½ to 6	58%	47½%	4½ to 6	33%	19%
7 and 8	54%	41½%	7 and 8	31%	17%
9 and 10	47%	34½%	9 to 12	21%	8%
11 and 12	46%	33½%			

BOILER TUBES—Standard gage, manufactured in accordance with the specifications and requirements of the American Society of Mechanical Engineers and in compliance with the rules and regulations of the U. S. Steamboat Inspection Service, from New York warehouse stock, per 100 ft.:

Size, Inches*	B.W.G.	Toncan Seamless Iron	Knobbled Charcoal Iron	Seamless Steel	Lapwelded Steel
1	13	$34.00	.....	$18.00	.....
1¼	13	37.75	.....	20.25	.....
1½	13	38.00	$38.00	19.25	.....
1¾	13	30.00	30.00	22.00	.....
2	13	26.25	26.25	20.25	$19.00
2¼	13	34.50	34.50	23.00	25.00
2½	12	34.00	34.00	26.00	24.25
2¾	12	40.50	40.50	28.50	27.50
3	12	42.50	42.50	27.00	25.50
3¼	11	50.25	50.25	30.75	28.75
3½	11	54.50	54.50	33.25	31.50
4	10	67.00	67.00	40.00	38.00

These prices are based on stock lengths. If cut to special lengths billing will be based on the entire stock lengths. In addition to the foregoing, standard cutting charges are as follows:

2-in. and smaller..	$0.05 per cut	3-in.....	$0.09 per cut
2¼ and 2½ in.....	.06 per cut	3¼ to 4 in..	.10 per cut

*External diameter.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft., New-Style, A.B.C., with fibre bushing:

B. & S. Size	BX Two Cond. M. Ft.	BX Three Cond. M. Ft.	Lead Two Cond. M. Ft.	Lead Three Cond. M. Ft.
No. 14 solid....	$33.85 (net)	$48.00 (net)	$180.00	$220.00
No. 12 solid....	136.00	180.00	225.00	275.00
No. 10 solid....	185.00	235.00	275.00	325.00
No. 8 stranded..	305.00	375.00	420.00	500.00
No. 6 stranded..	440.00	530.00	615.00	.....

From the above lists discounts are:	BX	Lead Covered
Less than coil lots	50%	30%
Coils to 1,000 ft.	60%	34%
1,000 to 5,000 ft.	63%	36%
5,000 ft. and over	65%	48%

CONDUIT—Rigid iron, price per 1,000 ft.; **ELBOWS AND COUPLINGS**, per 100 pieces, extra. New York warehouse shipment. Discount of 5 per cent for payment in 10 days; 30 days net.

Size, Inches	GALVANIZED Conduit	GALVANIZED Elbows	GALVANIZED Couplings	BLACK Conduit	BLACK Elbows	BLACK Couplings
¼	$59.96	$8.33	$4.79	$54.95	$7.21	$4.38
⅜	76.50	10.74	6.84	69.81	9.49	6.25
½	109.90	16.24	8.90	99.79	14.04	8.14
¾	148.69	21.97	12.48	135.03	19.31	11.47
1	177.76	29.31	15.41	161.46	25.76	14.17
1¼	239.20	54.71	20.55	217.25	47.20	18.90
1½	378.19	87.91	29.36	343.51	77.27	27.01
2	494.56	234.10	44.04	449.22	205.74	40.50
2½	621.96	516.92	58.74	567.64	454.09	54.02
3	758.30	597.18	73.41	693.95	524.78	67.50
3½	884.36	904.12	110.00	809.43	794.50	101.03
4	1029.65	1255.26	121.13	942.33	1103.08	111.37
5	1335.66	1560.33	176.12	1222.39	1371.20	161.93
6						

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less Than $10 List	$10 List to $100	$100 List and Over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$19.00
No. 16 cotton reinforced heavy		21.00
No. 18 cotton reinforced light		14.00
No. 16 cotton reinforced light		18.50
No. 18 cotton Canvasite cord		15.00
No. 16 cotton Canvasite cord		18.00
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$68.20	*74.00
No. 14 super service cord or similar (2 wire) in 1,000 ft.	102.60	*112.00

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List Each
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 65%; standard package, 68%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.....	$0.50	$1.10	100	10
35 to 60-amp.....	1.00	1.25	100	10
65 to 100-amp.....	2.00	3.00	50	5
110 to 200-amp.....	4.00	5.00	25	5
225 to 400-amp.....	7.50	11.00	25	1
450 to 600-amp.....	11.00	16.00	10	1

REFILLS—

1 to 30-amp.....	$0.03 ea.	$0.05	100	100
35 to 60-amp.....	.05 ea.	.06	100	100
65 to 100-amp.....	.10 ea.	.10	50	50
110 to 200-amp.....	.15 ea.	.15	25	50
225 to 400-amp.....	.30 ea.	.30	25	25
450 to 600-amp.....	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount Without Contract—Renewals:	
Broken cartons	Net list
Unbroken cartons	17%
Ten unbroken cartons	34%
Discount With Contract—Fuses:	
Broken cartons	5%
Unbroken cartons	20%
Ten unbroken cartons	36%
Discount With Contract—Renewals:	
Broken cartons	Net list
Ten unbroken cartons	36%

Carton quantities may be combined to obtain maximum discounts.

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500), per 100	$2.80
0-30 ampere, less than standard package, per 100	3.10

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt— Watts	General Type	Price Each	200—260 Volt— Watts	Special Type	Price Each
15	A 17	$0.20	25	A 19	$0.25
25	A 19	.20	50	A 21	.25
40	A 21	.20	100	A 23	.45
50	A 21	.20	...	....	.....
60	A 21	.20	...	....	.....
100	A 23	.35	...	....	.....

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f.o.b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$6.25	$8.90	$11.20	$19.00
12	9.90	11.40	14.00	25.00
10	13.50	15.40	18.50	33.50
8	19.90	22.50	25.00	47.50
6	.....	.....	36.00	.....
4	.....	.....	52.00	.....
2	.....	.....	72.00	.....
1	.....	.....	97.00	.....
0	.....	.....	119.00	.....
00	.....	.....	143.00	.....
000	.....	.....	176.00	.....
0000	.....	.....	215.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap— Key	Keyless	Pull	¾ In. Cap— Key	Keyless	Pull
Standard package	$0.12	$0.10	$0.16	$0.16½	$0.14	$0.20
Unbroken carton	.14	.12	.18	.18	.16	.21
Broken carton	.16	.14	.20	.20	.18	.24

WIRING SUPPLIES—

Friction tape, ¾ in., in less than 100 lb., 31c. per lb.; in 100 lb. lots, 29c. per lb
Rubber tape, ¾ in., in less than 100 lb., 33c. per lb.; in 100 lb. lots, 31c. per lb
Wire solder, in less than 100 lb., 33c. per lb.; in 100 lb. lots, 31c. per lb.
Soldering paste, 2 oz. cans ..... $1.10 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c. or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$3.50	$5.70	$9.00
60	9.00	11.00	14.00
100	14.00	17.00	29.00
200	22.00	29.00	48.00

Discounts:	
Standard package	40%
Less than standard package	35%